POWER

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Interest and Application

I HAVE a friend who has the oversight of a number of power plants and of many men.

He deplores the growing lack of application and interest, the rarety with which he finds a man who loves work for work's sake, the fellow who would rather stick around and try something out or learn something than to duck as soon as the whistle blows.

I don't know whether he is right about this kind of man becoming scarcer or not. There always were a lot of the other kind.

He himself would keep dinner waiting any time to do something that he thought would make the plant run better or cheaper the next day or to try out something that he could not do during running hours. That is how he got where he is.

And in the evening at home, he was reading and studying something that would make him a better engineer. That was because he was interested in his profession.

And, after all, the mainspring of success in engineering, as in everything else, is interest. A man can do almost anything if he is interested enough in it.

It is not always lack of knowledge that keeps a man back. My friend complains of a technical graduate among his men who is devoting his best efforts and his technical training to the production of home brew. It is impossible to imbue him with any real interest in the power-plant problems about him. He may turn out to be a good braumeister, but he will never be a successful power-plant engineer unless in some way the spark of interest is kindled that will make him think and wonder and delve and solve the question of making a power plant run more continuously and efficiently.

For a man who has this kind of interest —the man whose position, however lowly, is to him an opportunity and not merely a job—the whistle is simply a signal for a change in the direction or character of his effort. He is out to become an engineer, and he does not stop working at it when the clock strikes. His day's work is as engrossing as a game. He is more interested in his week's fuel record or output per pound of coal than he is in the contents of his pay envelope.

The time server is working only for his employer, but the engineer with his mind aflame with interest in his work is working upon and for himself; and if his present employer does not recognize the better service that he is rendering, and if his present position does not offer an opportunity for the talent and capabilities that he is developing, there are other employers and positions that will.

There is always room at the top.

F. R. Low

Plant Improvement Shows Large Saving

An Expenditure of $30,000 Saves $60,000 a Year at the Plant of the International Motor Company

THE business of the International Motor Company had been expanding so rapidly that about three years ago it was decided to spread out and acquire a plant in New Brunswick, N. J., from a concern that had been engaged in war work. The plant consists of a large foundry and machine shop.

The first winter after the present owners moved in, an average of 50 tons of coal was consumed daily and great difficulty was experienced in the way of providing steam enough for both heating and power. It was also found necessary to carry a large crew of men for the purpose of keeping the system in repair. The maintenance expense was so great that it obviously was not possible to operate economically under these conditions.

The management realized that it would take considerable time and expense to revamp the old system, and careful thought was given to obsoleting the old plant as a whole and putting in an entirely new power plant and heating system. A detailed study showed that this would involve too great an expense, so it was decided to revamp the old system.

The work was undertaken under the supervision of A. J. Morrison, the plant maintenance engineer, and with a few very modest layouts he started to revamp the entire heating system early in May, 1921. In October the steam was turned on the new system, and the plant, instead of consuming 50 tons of coal daily, last winter averaged only 15 tons.

Since these changes were made, other plans have been formulated and some partly fulfilled, whereby, in the winter time, the steam-driven generator will develop power up to its full capacity, the exhaust steam from the generating unit being used for heating the plant. During the summer months practically no current will be generated by steam power, but will be purchased from the local public-service plant. This turned out to be the most economical arrangement, when tried last summer.

The changes made it possible for three boilers, now operating at 200 per cent rating, to do the work of eight used originally. Also a large saving was effected by approximately doubling the evaporation per pound

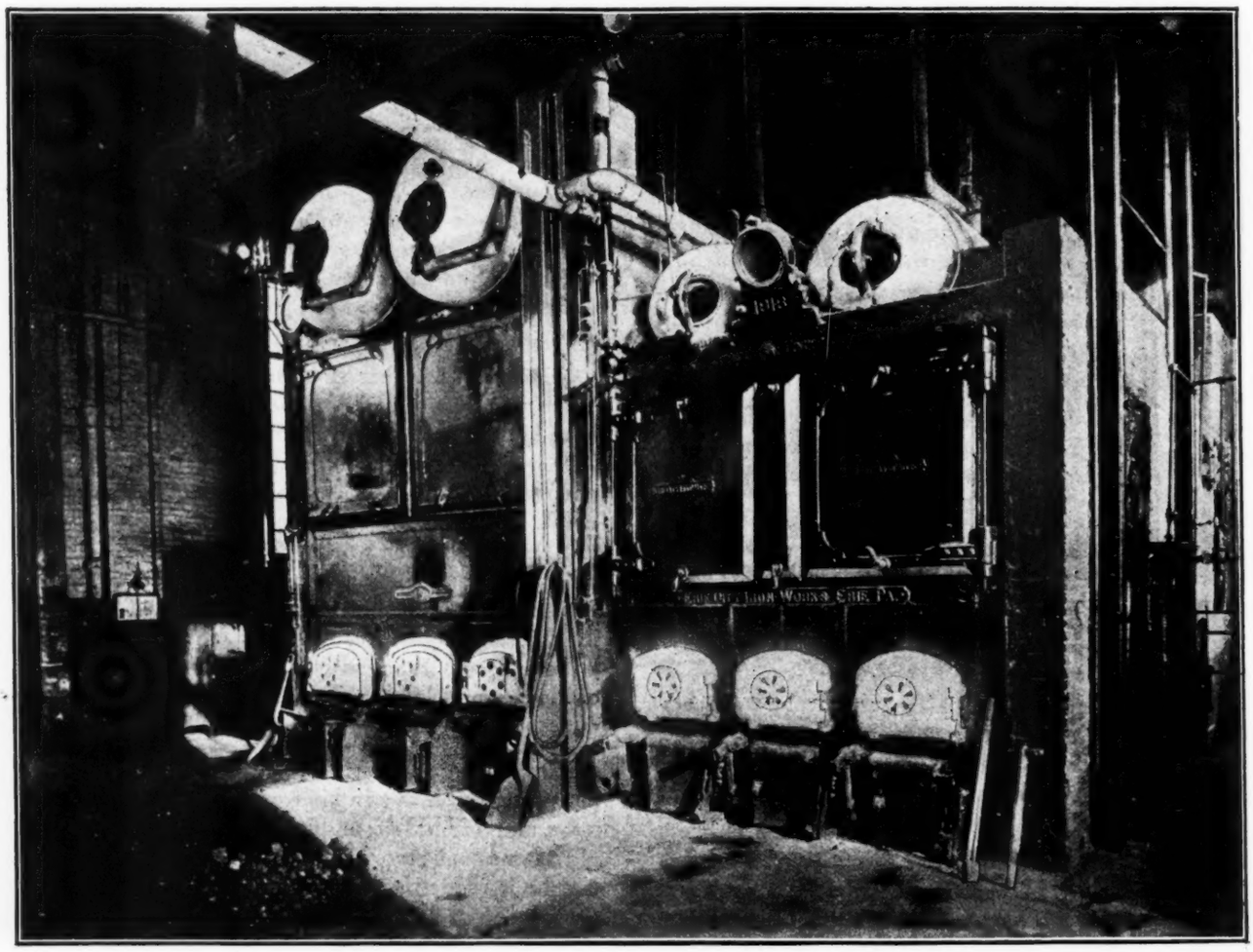


FIG. 1—HAND STOKERS APPLIED TO A 3,000-SQ.FT. AND A 2,300-SQ.FT. WATER-TUBE BOILER

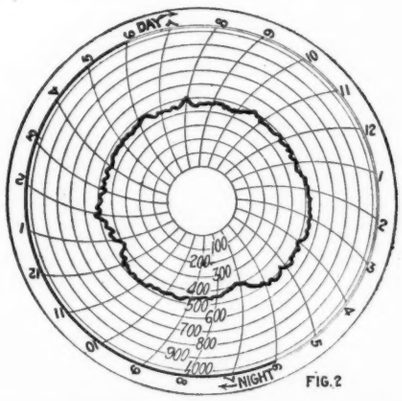


FIG. 2—STACK TEMPERATURES OF FIRE-TUBE BOILER AT 200 PER CENT RATING

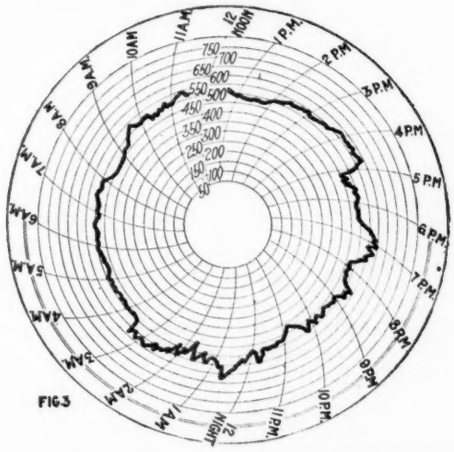


FIG. 3—STACK TEMPERATURE OF WATER-TUBE BOILER

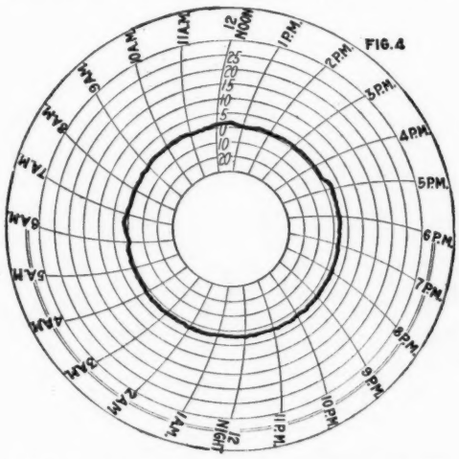


FIG. 4—PRESSURE OF HEATING SYSTEM USING FULL HEATER PRESSURE

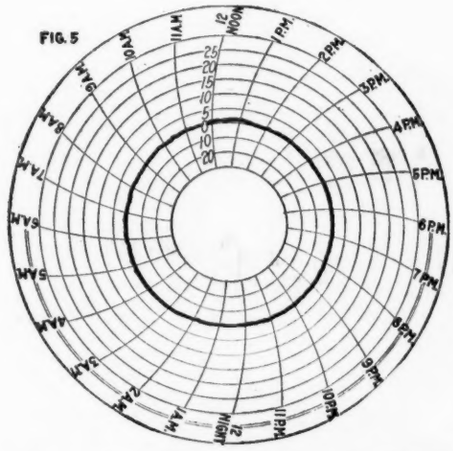


FIG. 5—PRESSURE OF HEATING SYSTEM USING REDUCED HEATER PRESSURE

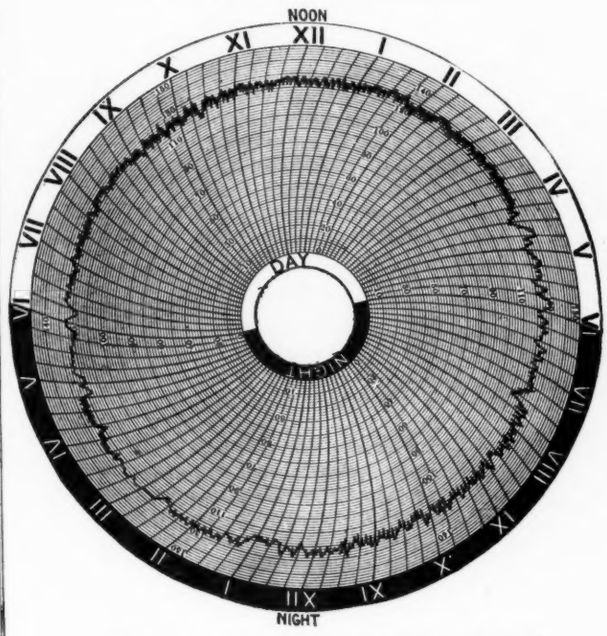


FIG. 6—MAIN STEAM PRESSURE AT THE BOILER HEADER

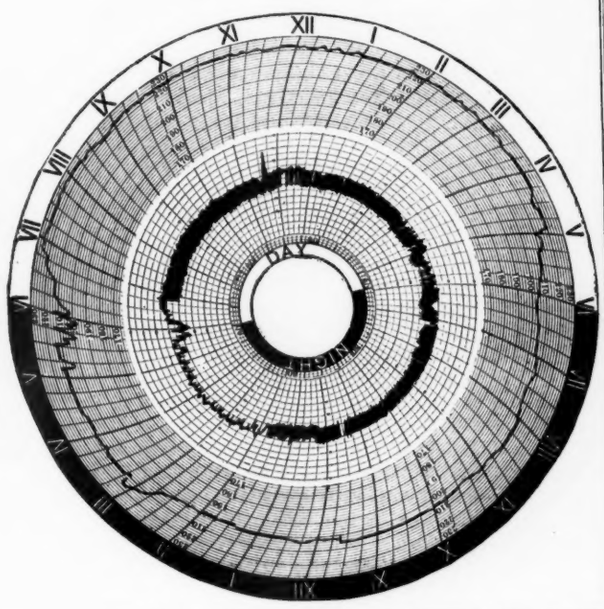


FIG. 7—HEATER PRESSURE INSIDE AND FEED TEMPERATURE OUTSIDE

of coal, resulting from a change of boiler baffling and the application of hand stokers, and the smaller operating force required.

The back-pressure heating systems were changed into combined atmospheric and vacuum systems, now being supplied from the main power house which previously

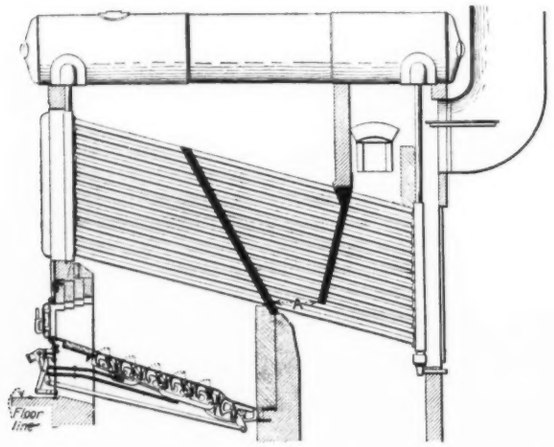


FIG. 8—BAFFLING SCHEME IN WATER-TUBE BOILERS, WITH THROTTLING AT *A*

had scarcely been able to take care of one system. A closed feed-water heater of larger capacity operating at six pounds back pressure, replaced the smaller heater, operating at ten pounds back pressure, and the feed-pump capacity was increased.

Steam blowers and hand-fired stokers were fitted to each of the four power-house boilers. Fire walls of the new settings were coated with airtight flame-proof cement, and a monolithic baffling, fitting the tubes closely, was installed.

As will be seen in Fig. 8, in the water-tube boilers a point of constriction or throttling is introduced in the gas path at *A*, while the areas of the remaining passages are approximately doubled. With the standard baffling, stack temperatures ran hot enough at times to burn out the pyrometer. The throttling at *A* prevents increase in gas velocity when the draft increases, as the resistance is so great that only a small increase of gas velocity is required to use up a large increase of draft

CONSERVATIVE ESTIMATE OF SAVING DUE TO CHANGES

	June 1, 1918 to June 1, 1919	June 30, 1921 to June 30, 1922	Saving	Saving
Total tons coal	12,738	5,133	7,605	.....
Cost per ton	$9	$7	.....	
Savings at $7 per ton				$53,235
Operating force under the chief engineer:				
Asst. engineers	3	3	0	.....
Oilers	3	0	3	.....
Savings 300 days per year at $2.50 per day	.....	.....	.....	$22,250
Firemen, regular	12	3	9	.....
Savings at $3 per day	.....	.....	.....	$8,100
Extra fireman, 100 days	9	2	7	.....
Savings at $3	.....	.....	.....	$2,100
Boilermaker, 300 days	1	0	1	.....
Savings at $4 per day	.....	.....	.....	$1,200
				$66,885

Note: Records of the power loads are not available, but the shops used approximately the same amount of power for each year. Power was furnished by the engine during the period covered in the estimates.

power. The gas velocity is therefore held more nearly constant. The design of the passages produces the lowest velocity for the hottest gas. Note the chart of stack temperatures, Fig. 3, carrying a peak load.

The same principle, developed by S. D. Smith, of the King Refractories Co., is applied to the horizontal return-tubular boilers (see Fig. 9). An exterior view of these boilers appears in Fig. 10. In this case a wall was built under the return end of the boiler, with side openings at *A* for throttling. These were placed considerably below the boiler shell, so as to guide the gas better for making the turn into the tube ends. There is no apparent tendency in these horizontal return-tubular boilers to crowd gases in the upper tubes in a way that often gives trouble.

Two hundred per cent rating may be carried without forcing and without injury to the boilers. Evaporation with hand firing was in the neighborhood of 5 lb. of water per pound of coal, but now is 10 lb. or more. In June, 1922, this averaged 10.71, and on Feb. 17, 1922, with a 4-deg. outside temperature, it was 9.54. The charts shown in Figs. 2 to 7 were taken on this day.

One Heating Plant Replaces Three

Two plants, of two boilers each, originally furnished heat for two buildings. A third heating system was operated in connection with the power house, using the exhaust steam.

The present scheme provides all heating to be furnished by exhaust steam from the power house, supplemented when necessary by expanding live steam through a reducing valve. Three boilers totaling 6,800 sq.ft., now carry a peak formerly requiring eight boilers of 14,000 sq.ft. The total heating load approximates 40,000 sq.ft. of radiating surface.

Exhaust steam is furnished by a 20x36x125-in. compound Corliss engine driving a 200-kw. generator, and two air compressors, one 150 hp. and the other 100 hp., operating at 125 lb. per sq.in. steam pressure non-condensing.

The steam-driven units originally exhausted into the heating system, protected by a relief valve, at back pressures varying from 5 to 10 lb. per sq.in., which at times surged up to 20 lb. per sq.in. Returns from the heating system were used in a closed heater.

A larger closed heater replaced the former, and a weir meter for measuring feed water was added. The

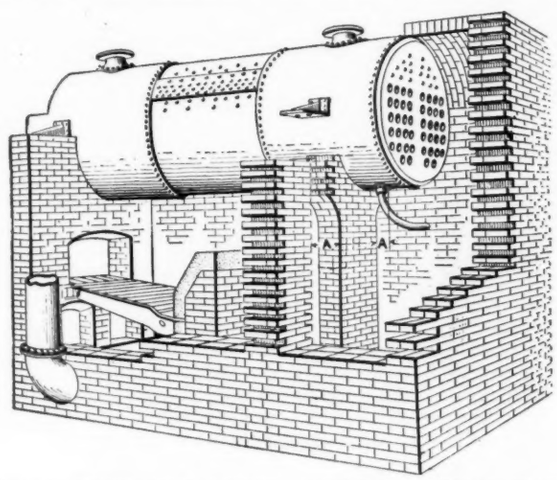


FIG. 9—FIRE-TUBE BOILER CONTAINS SPECIAL WALL FOR THROTTLING GASES

steam units were arranged to exhaust directly into this heater, at 4 to 6 lb. per sq.in., and steam for the entire heating system was drawn from this source. A reducing valve was arranged to supply makeup steam from the boiler header when necessary. A blowoff valve is connected, set at 6 lb. per sq.in. The chart of heater pressure and feed-water temperature, Fig. 7, shows

conditions on Feb. 17 and indicates that temperatures upward of 220 deg. F. and pressures of 3½ to 5 lb. per sq.in. were maintained during the daytime, corresponding with the temperature of evaporation, which is 225 deg. at 4.3 lb. gage.

The heating system formerly supplied by the power house now uses steam reduced from heater pressure to atmospheric pressure by an automatic valve, and is charted in Fig. 5. The remainder of heating steam is supplied at full heater pressure, chart, Fig. 4, being recorded at the most distant building.

It can be seen that this method allows the engines to work at a lower pressure during the heating season, also lowering the pressure of the heating system so that heat is utilized at a lower range of temperature, and allowing full condensation instead of hot steam returned, and greatly eliminating blowoff losses.

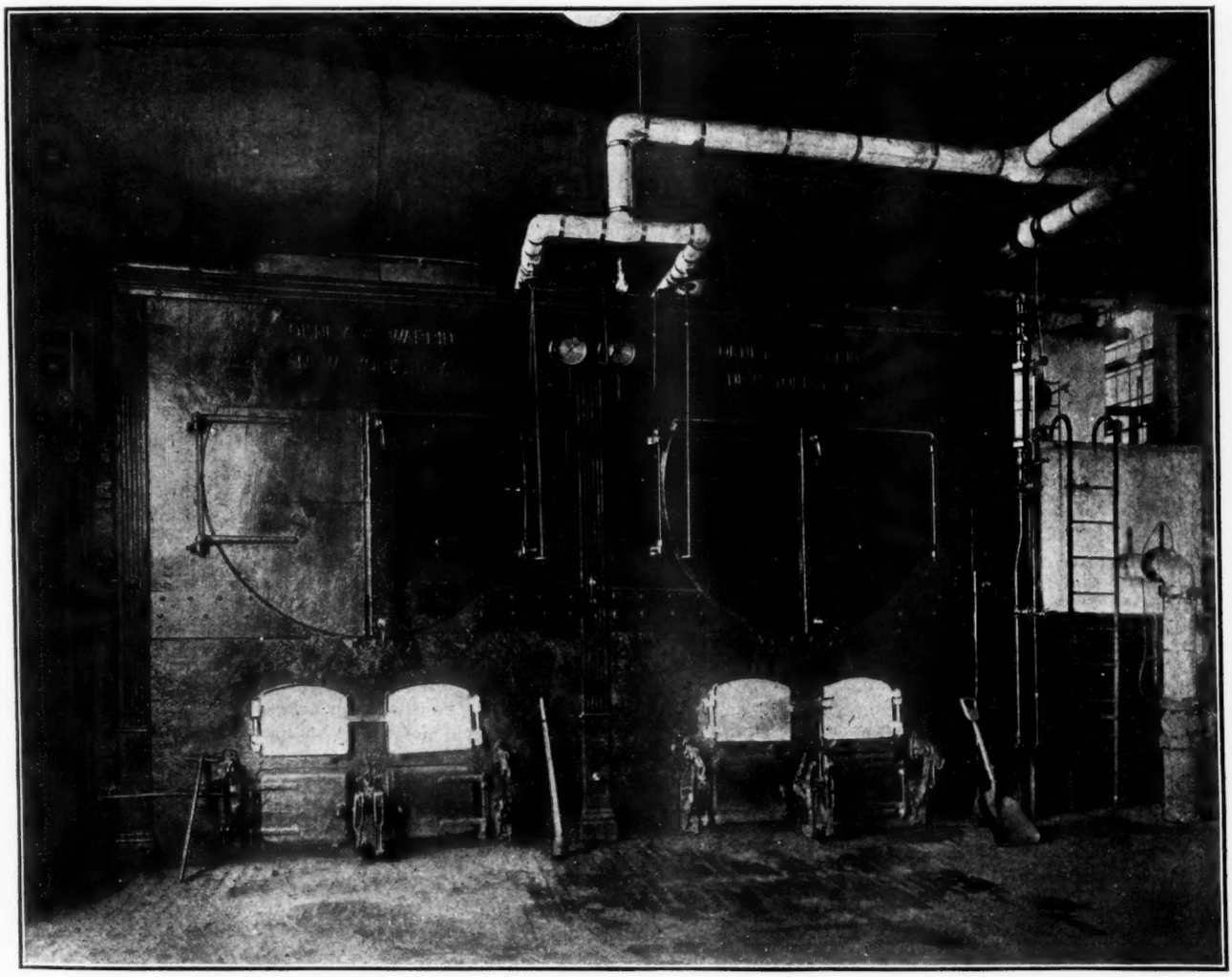


FIG. 10—FIRE-TUBE BOILERS OF 1,500 SQ.FT. HEATING SURFACE EACH

Combined Atmospheric and Vacuum System

Circulation in the heating system is largely produced by condensing and cooling rather than an appreciable steam pressure; since the difference in height between supply and return lines is comparatively small, it is therefore essential that no air pockets interfere. Mr. Morrison has devised a positive system for removing air, which gives thoroughly satisfactory results.

The return of each heating system is led to a closed tank at approximately atmospheric pressure. The condensate escapes into traps, while the air is removed from the tank and convenient points of piping by means of a 10-in. vacuum, operating through thermally and float-controlled valves which, however, prevent water or steam passing. The vacuum is furnished by the discharge pump and is prevented from reaching the tank through condensate lines by means of the traps; Fig. 11 is a general scheme of this method.

A pump regulator maintains a 10-in. vacuum pump suction. The discharge water and air are delivered into the heater against 5 lb. back pressure. The greatest discharge head is against a 60-ft. lift to the heater, 2,000 ft. distant. Air removed is thus pumped to the heater, where it is eventually discharged under the blowoff valve at the top when excessive pressure occurs.

Four traps are provided to handle the condensate, forming duplicate systems and facilitating repair work without interruption. The globe valves for cutting out the traps are not shown in Fig. 11.

The air-extraction valve will pass air but not water or steam. When water enters, it will compress air in the bell, forming the pocket *P* in Fig. 11 and causing the bell to be buoyed upward, closing the valve at the top, which prevents water from escaping. If air

now enters through the lower connection, it will be collected in this pocket, enlarging the pocket until air escapes around the bottom of the bell, reaching the top of the water space and forming another air pocket under the valve. When this second air pocket is sufficiently large, the bell will sink on account of insufficient water to buoy it up, thus opening the valve and allowing

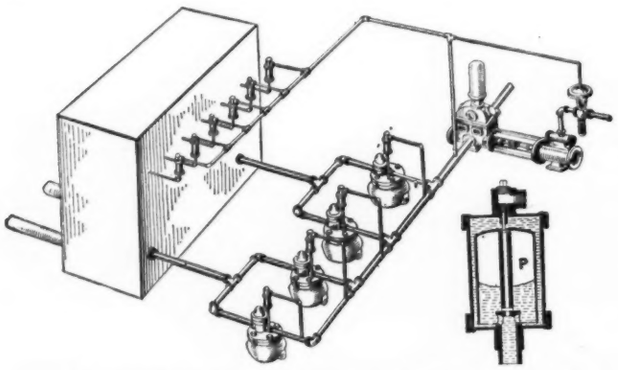


FIG. 11—PLAN OF PUMPING HEATER DISCHARGE
Condensate is trapped and discharged to 10-in. vacuum. Air is extracted by means of special valves, some of which connect to air pockets in return lines, not shown in the diagram. Valves for cutting out traps, etc., are not indicated on drawing.

the air to escape. Steam closes the valve on account of heating the expansion element, which runs vertically through the pocket *P*, thus lifting the bell and closing the valve.

Firebrick, monolithic baffle and seamless cement coating employed in making the alterations were furnished by the King Refractories Co.; Argand blowers and McClave stokers by the McClave-Books Co., and air-extraction valves by the Donnelly System Co. The new material also includes a Swartwout heater and Yaryan weir meter.

Replacing a Cylinder on a Large Gas Engine

BY EARL PAGETT

The cylinders on a large double-acting tandem gas engine became so badly cracked that it was necessary to replace them, and a description of the procedure may be of interest.

As there were only four units in this plant and three required on the load, the first thing that was done was to keep the engine with the bad cylinders on the load as much as possible, and shut the other three units down, one at a time and put them in the best running order, so as to head off any possibility of a shutdown while the cylinders were being changed.

This accomplished and the new cylinders being at hand, the load was given to the other engines, and dismantling begun.

The inlet and the exhaust valves were removed first. All water connections to the cylinder heads and packing cages came off next. The piston rods were then unloosened from the main, intermediate and tailrod crossheads, and the crossheads removed.

After the cylinder heads and the packing cages were taken out of the way, the pistons were removed, as was the camshaft. Everything now being stripped off, the tailrod guide frame was taken loose from the rear cylinder and slipped back out of the way. However, the foundation plate was not long enough to allow it to go back far enough to clear the cylinder stud bolts, so a cribwork had to be built up to take the weight of one end.

The weight of the cylinder was now taken on the crane, and the nuts on the studs that held it to the intermediate frame piece were taken off. This allowed the cylinder to be backed off until the studs cleared the frame.

This cylinder being disposed of, the forward cylinder was taken loose from the intermediate frame, and the frame moved back to clear the studs. As the foundation plate under this frame piece was much longer than the rear one, no cribbing was necessary.

This cylinder was now supported by the crane, and when the nuts had been removed from the studs that held it to the main frame, it was moved to one side.

The cylinders fitted to the frame pieces with ring and groove joints, and all the machined surfaces of these joints were scraped and cleaned thoroughly. The new cylinders were then put on in the inverse order to that in which the old ones had been taken off.

The studs were a loose fit in the holes in the frame-pieces and the ring and groove almost a press fit. It was assumed that the machining of the cylinders was accurate and that the cylinders and frame pieces would align if the joints were properly made.

The openings for the inlet valves on top of the cylinders were machined and were used to level from, so as to get the center lines of the valves in an exact vertical position.

When the stud-bolt nuts were drawn up, care was taken to tighten equally all around. The joints were next tested out with a feeler gage to be sure that they were tight all the way around.

A fine wire was next stretched through the cylinders out past the crank disk, and set central at both ends by tramming. The cylinders were trammed clear through and found to be square with the flanged ends.

The main crosshead guide was of the bored type, and there were two lugs cast on either side of the frame, level with the horizontal center line. These lugs had been bored to the same radius and at the same setting as the guide. The lugs were now trammed for alignment with the center wire and were found correct.

A prick-punch mark was made on the crank near the crankpin, and with the crank near dead center a tram was made, one end of which would set in the punch mark and the other end barely touch the wire. The flywheel was now turned halfway over and the distance between the wire and the mark trammed again. This test showed that the crankshaft was at right angles to the center line of the cylinders. The shaft was tested by placing a spirit level on its top, and it was found slightly out of level, which was corrected by raising the outboard bearing.

Everything having been checked for alignment and found correct, the various parts were reassembled in practically the reverse order to that in which they had been removed, and everyone drew a good big breath of relief when the engine was safely back on the load again.

If a 60-cycle transformer is to operate on a 25-cycle circuit, the voltage should be reduced to about one-half normal, and the capacity will be correspondingly reduced; otherwise high temperatures will result in continuous operation. Conversely a 25-cycle transformer can be operated on a 60-cycle system at double the voltage at which it is rated for 25 cycles, providing the insulation will safely withstand the increased voltage.

New Type of Electric Steam Generator

Applications of the Electric Steam Boiler—Construction and Operation of a New Type Described in Detail—Economy of Using Electric Boilers To Absorb Excess Power from Hydro-Electric Plants

By E. M. HORSTKOTTE
Power and Mining Department, General Electric Company

DURING the coming winter and probably for some time afterwards, fuel economy and existence are going to be synonymous terms for the industries of this country. Therefore particular interest attaches to any means of power generation, especially necessary steam for heating or process work, that will materially cut the consumption of coal or fuel oil.

Such a means has arisen in the electric steam generator, which has already demonstrated its value in certain industries and whose field in this line of service is large. Central stations both in the United States and Canada have already found the steam generator a splendid means of utilizing excess power from hydro-electric plants. Pulp and paper mills in both countries are using it for "ironing out" their load curves and for using surplus energy from water-power plants to produce necessary process and heating steam. Many of them have surplus electrical energy, throughout the day as well as on Sundays and holidays, that can thus be turned to good account.

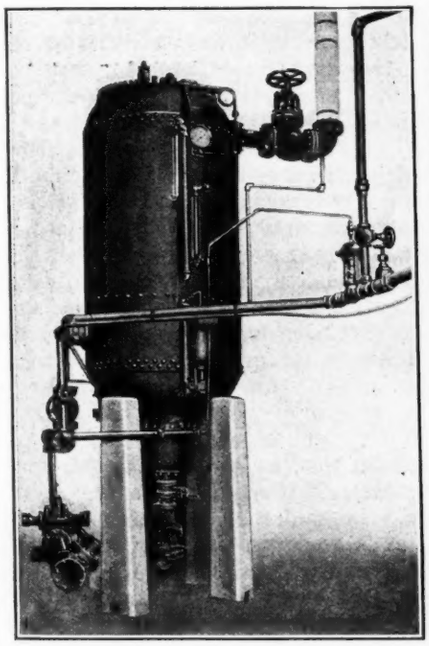
After considerable investigation the General Electric Co. has designed an electric steam generator in which first consideration has been given to the three principal requirements of its service—simplicity, safety and reliability. The equipment, as installed, may be said to form a complete steam-generating plant which is capable of operating with minimum attendance, is compact and is easy to install. It requires power at the approximate rate of one kilowatt-hour for every three pounds of steam generated.

The complete equipment consists of the shell with supporting feet, the electrodes, insulators, steam and water gages, safety valve, circulating pump and motor, and a panel on which is mounted the control equipment (see Figs. 1, 2 and 3).

The tank, or generator shell, is mounted vertically and divided horizontally into two compartments, the upper known as the electrode compartment, where the actual generation of steam takes place, and the lower forming a self-contained hotwell (see Fig. 2). Water entering the hotwell from the feed-water pipe is forced into the upper chamber by the motor-driven centrifugal pump *M*, located on a short external pipe line. From this chamber it flows back into the hotwell through a number of small pipes *S* on the outer circumference of the dividing plate. This arrangement provides a continual circulation of heated water, the water level in the electrode chamber being held at the desired level by setting the valve in the circulating-pump discharge line. Pipe *P* is the blowoff and the one just above is the feed-water.

The upper, or electrode, chamber, where the steam is generated, contains three large round-iron electrodes *E* rigidly supported from the roof, the current-carrying supporting rods coming in through specially designed insulating bushings. These bushings are provided with a small duct in the top leading to the outside air. Thus if steam does succeed in leaking through the packing into the upper section of the bushing, it passes out freely instead of creating a pressure that might blow out the side of the insulator.

The electrical operation somewhat resembles that of



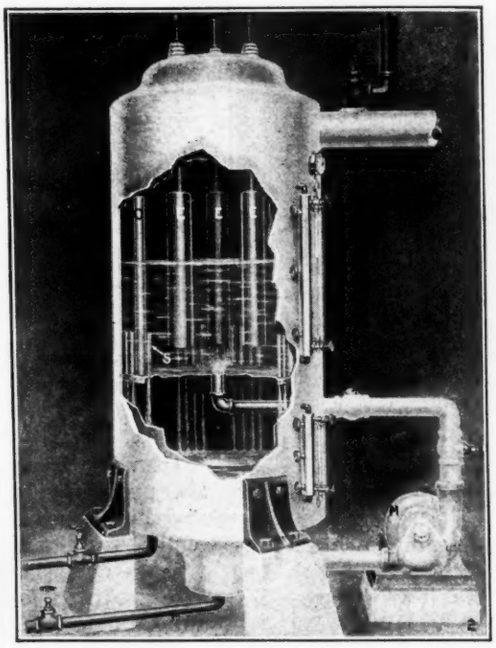


Fig. 1—Assembly of electric steam generator.

Fig. 2—Section of steam generator shell cut away to show internal arrangement of parts. The shell is divided into an upper and lower chamber. The lower chamber acts as a hotwell and is where the feed water enters. Pipe *P* is the blowoff, with the feed-water pipe just above. A circulation of the water is maintained between the hotwell and the upper chamber by pump *M*. After being pumped into the upper chamber, the water returns to the hotwell by way of small pipes *S*. The overflow pipe *O* prevents the boiler being flooded and also acts to equalize the pressure between the upper chamber and the hotwell. Power is supplied to the water through the electrodes *E*.

a three-phase arc furnace. Normally, the electrodes are submerged in the water, and the three-phase current passes through the water to the sides of the tank and to the neutral of the system, also from electrode to electrode. The steam is generated by current flowing through the water, which is of high resistance. The mechanical circulation of the water has been described, but some of the operating features arising from it are of sufficient interest to merit further description. One result is that the temperature of all the water in the system is practically uniform. If the steam pressure lowers owing to an increased

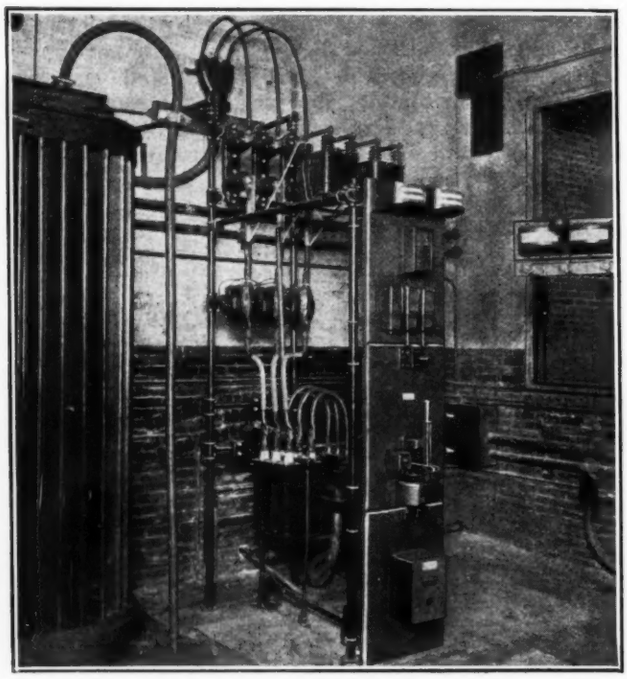


FIG. 3—CONTROL FOR ELECTRIC STEAM GENERATOR

demand, rapid steam generation, due to the high temperature of the water and the degree to which the electrodes are submerged, quickly brings the pressure up again.

Another operating feature is that since the water level is maintained by the adjustment of the throttle of the circulating pump, the energy consumption of the generator is not dependent on the operation of the feed-water pump. The supply of water in the hotwell is regulated by an automatic feed-water regulator. Furthermore, when it is desired to reduce the load, the generator does not have to be blown. The only energy losses in the circulating-pump operation are the motor losses and the bearing friction losses. Practically all the energy delivered to the pump impeller goes into heat in the water, therefore, the loss from this source is small.

There is no difference in pressure between the hotwell and the steam-generating chamber, as these are connected together by openings for taking care of excess water in the upper chamber. In case the water level in the upper chamber is higher than that for which the boiler is designed, this level is automatically maintained at some maximum point and the excess water will flow through the openings referred to. This eliminates all danger of submerging the porcelain insulators and prevents overloading the boiler by high-water level.

In the high-voltage boilers—that is, for approximately 6,600 volts—the electrodes are arranged so that current passes from electrode to electrode and also from electrode to the inside basket, which serves as a neutral point. An inside basket is used instead of the boiler shell so that the latter will carry very little current. In the low-voltage boilers all the current flows from the electrode to the basket. In this type of installation the electrodes consist of flat plates and the basket consists of two concentric sheets of iron properly spaced with the electrodes in between them. The basket then forms a neutral point and also a ground to the boiler shell. Any type of electric boiler will make a high-resistance ground on the system due to the boiler's inherent construction, except where the heating elements are installed as in some small types using direct-current.

These electric steam generators have been designed for pressures ranging from 200 lb. maximum to 15 lb. minimum. Tentative layouts have also been made on generators of 3,000 kw. capacity operating at one pound pressure. These generators can be designed for any boiler pressure now being used, up to 50,000 kw. capacity and down to 250 to 300 kw. Below this lower limit generators of this type would probably not be as economical to build as some sort of immersion type using a metallic resistor.

Fig. 3 shows the control equipment, which consists of an incoming line panel carrying automatic circuit breakers, the necessary meters and instrument transformers and the control apparatus for the circulating pump. Since the kilowatt capacity of these boilers is comparatively large, the devices used on the board are of the same heavy construction and have the same current carrying and rupturing capacity as those used in substations, and heavy feeder circuits, tie lines, etc., for similar duty.

Importance of Safety Factor

Of vital importance in this, as in all apparatus for the production of steam, is the safety factor. For several reasons it may be said that the safety factor of the steam generator is even greater than that of the average boiler, highly developed as the latter is. The safety valve takes care of excess pressure, as on the standard types of boilers, and the method of protecting the insulators has already been described. Further contingencies are taken care of by what may be described as the interlocking of the various controls. Suppose, for example, the circulating pump ceases to function, from voltage failure or other cause. The water in the electrode chamber simply drains into the hotwell, and since the electrodes are no longer submerged, no more steam is generated. On resumption of the pumping, since there is no hot metal surface in the electrode chamber, there is no danger of an explosion similar to that due to a hot crown sheet in a boiler. Also, when the water drains out, there is no danger of burning any part of the electrode chamber because when there is no water there is no heat generated. Too high a level of the water is prevented by an emergency overflow pipe *O*, of large diameter, whose top is some distance from the top of the electrode chamber.

A consideration of the steam supply problems of industrial plants has disclosed many cases where the steam generator would prove a valuable adjunct to the plant equipment, either in utilizing excess electric power formerly wasted or in providing process steam

directly where it is needed. In the case of paper mills there are at least fifty-nine days in the year when the plant is idle, yet a supply of steam must be maintained for various purposes. Ordinarily, this means that a certain amount of steam must be kept up in the boilers, and that, in addition to the fuel, necessitates the presence of firemen and engineers over the idle period. Where it is economical to install an electric steam generator, it would operate practically without attendance except for a cursory inspection by a watchman, and its use would permit the banking of the fires if coal were used, or the shutting down of oil-fired boilers when the plant was idle.

Purchasing Power on Maximum-Demand Basis

Many mills purchase power on a maximum-demand basis and here savings can be effected by the steam generator, but arise from a different cause. Suppose, for example, a factory contracts for 10,000 kw. maximum demand. It is possible that, owing to one cause or another, the load factor for the year may be as low as 75 per cent. In such a case 2,500 kw.-years, or 21,900,000 kw.-hr. are being paid for but not used. By installing an electric steam generator to utilize this energy the fuel bills would be cut materially. Assuming a coal-fired boiler with an efficiency of 65 per cent and coal with 13,000 B.t.u. per pound, for every 4,953 kw.-hr. used in the generator one ton of coal would be saved, or 4,421 tons per year. If oil-fired boilers are used, operating at 75 per cent efficiency, and using oil weighing 8 lb. per gal. with 18,700 B.t.u. per pound, for every 32.9 kw.hr. there would be saved one gallon of oil, or 665,650 gal. per year. These figures are calculated on the basis that all the excess energy would be utilized. If only 75 per cent was so utilized, the savings would still be enough to more than justify the installation of a steam generator.

In addition to those mentioned, other possibilities have presented themselves. Companies operating hydro-electric central stations have found it of mutual advantage to themselves and their customers, to install and maintain one of these generators in the customer's factory, metering the steam and charging the customer according to the amount consumed. Industrial plants supplied with power by their own hydro-electric generating stations can use the excess energy available during high-water periods to generate steam and save fuel. Another field is in factories needing small amounts of process steam at widely separated points. It would be much more economical to install a generator at the point of utilization than it is to transmit steam for long distances from a central source of supply. As time goes on and the knowledge of the advantages of the electric steam generators is more widely spread, doubtless many uses will be found for it which are as yet undeveloped.

Poor workmanship in soldering, in removing too much or too little insulation on electric wires, often causes trouble later on. Enough insulation should be removed to permit the wire to extend well into the terminal, but not to leave exposed wire outside of the terminal. Little details like these, which are so easily overlooked, may be the source of considerable trouble. Where the wire is held mechanically at the ends, care should be taken to see that all nuts, washers and locknuts are in place and are tightened securely. A loose wire is a hazard that never should be permitted.

Notes on Ammonia Condensers

To clean atmospheric condensers of scale, a stiff wire brush and a hammer will do the job. For double-pipe condensers the scale must be removed by a drill or tube cleaner.

All gaskets on the condenser should be renewed once a year. Rubber gaskets wear and rot, while lead gaskets quite often give enough to leak, so all should be inspected and renewed.

If the several stands do not work evenly, the water supply may be unevenly distributed. One of the stands may be partly closed off by the valves being improperly set. Only by experimenting can the engineer discover how to make each coil do its share.

To determine whether coils are condensing alike, see that an equal amount of cooling water is supplied to each coil, and then feel the ammonia gas inlet to each coil to see that they are all the same temperature; also feel the last pipe where the ammonia leaves the coils.

If they are all of the same temperature, the coils are working alike. If one coil is cold and another hot, the coils are not doing the proper amount of work, the hot coils doing too much work and the cold coils not enough. To equalize the work, choke the valves on the hot coils slightly and open the valves a little on the cold coils. If the valves are choked too much, the pressure will rise; therefore, the valves should be adjusted so as to secure the lowest condensing pressure with all coils working equally.

Often the engineer finds the condenser pressure high even though there is ample cold water going over the coils. This pressure is mostly due to foreign gases.

The usual manner of purging is simply to open a valve at the top of the condenser and allow the gases to pass into a pail of water. Careful engineers make a point of stopping the compressor and keeping the cooling water on the condenser from half an hour to several hours before purging, the idea being that all the ammonia will be condensed and only the inert gases will remain. This is an improvement on the first method, and it is becoming better known every day that a larger amount of ammonia is lost through the purge valve by the usual method.

This loss of ammonia is due to the fact that the law of partial pressures and the law of diffusion hold for ammonia as for a mixture of perfect gases. This means that the only advantage of running water on the condenser and stopping the condense is to cool the mixture of gases and condense out *some* of the ammonia.

The lower the temperature in the condenser the greater will be the percentage of ammonia condensed. To reduce the loss of ammonia vapor which escapes with the air in purging, an extra header above the condenser with which all the coils connect may be used. Into this header is run a liquid line so that a small amount of liquid from the receiver which, being shut off, is at a higher pressure, is expanded into the header. This cools the ammonia gas and reduces the loss.

To remove the foreign gases, a line is led to a bucket filled with water. The gases will bubble up through the water, but as soon as much ammonia escapes it will give out a cracking noise in the water.

The receiver should be placed below the condensers and in a fairly cool place. The engine room is too hot for it and causes a loss by its liquid absorbing heat from the room.

Errors To Avoid in Indicating a Diesel Engine

MANUAL facility in using an indicator is quickly acquired by practice, but it is often the case that oil-engine indicator diagrams are not correctly interpreted because the operator does not have a full appreciation of the many mechanical factors that affect the operation of the instrument.

A PRIME requisite in an indicator for oil-engine work is heavy and rigid construction. This applies to both the indicator and its attachments, such as stop cocks, elbows, etc. Such a design is necessary not only to enable the indicator to withstand the ordinary wear and tear in service, but also to give the indicator assembly rigidity enough to prevent deflection due to the pull of the cord against the spring.

A simple method of testing the indicator for rigidity is to put a light wooden stick as a brace between the drum arm and the engine cylinder, as shown in Fig. 1, take a card, then remove the brace and trace another

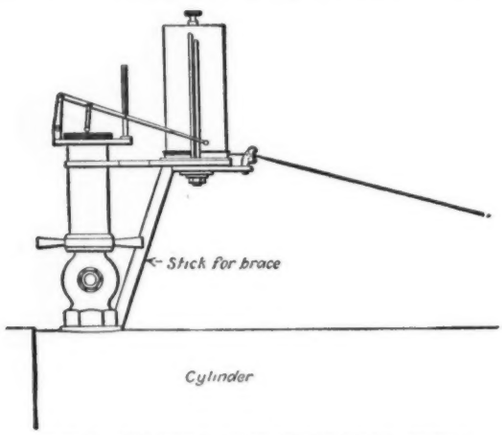


FIG. 1—MAKING THE INDICATOR RIGID

diagram on the same card. Fig. 2 is a reproduction of two actual diagrams taken in this manner. The full-line diagram was traced with the brace in position, and the dotted-line diagram was taken with brace removed. This shows that the diagram was shortened about $\frac{1}{16}$ in. and the combustion line distorted by bending of the drum arm on the indicator, and illustrates very clearly the necessity for rigid construction.

Another common cause of error in indicator diagrams is the stretch of indicator cord. On this account the use of any kind of cord should be avoided wherever possible and the connection between indicator and reducing motion should be made by means of fine wire or steel ribbon. The majority of vertical oil engines have a lever reducing motion so that when the piston is at the top of its stroke the cord is pulled out against the drum-spring tension. An example of the effect of a stretching cord is shown in Fig. 3. This diagram might be diagnosed as a case of retarded injection, incorrect valve setting or slow burning, but Fig. 4, which is a diagram taken immediately afterward from the same cylinder using a wire in place of the cord, shows the trouble to have been caused by stretching of the cord. In this case this conclusion was verified by pulling the cord by hand, and it was found possible to stretch it about two inches. Study of the diagram will show that at the beginning of the compression stroke a normal diagram was traced, but toward the end of the compression stroke the drum-spring tension became sufficient to start the cord stretching, and the drum then remained stationary until the rest of the compression stroke was completed and enough of the working stroke to take up the stretch of the cord.

The passage through the engine cylinder head to the indicator cock is usually very small, and if a stop cock is placed between cylinder and indicator cock, the passage through the stop cock is still smaller. It may happen that these passages will become partly choked with carbonized oil, especially in the stop cock. If this proceeds far enough the passage will become constricted enough to reduce the gas flow sufficiently to give the effect of a very much "leaner" diagram. Fig. 5 shows in heavy lines a diagram taken under this condition. This diagram is apparently normal, but a knowledge of the approximate power the cylinder had been developing at the time the diagram was taken indicated that the diagram area was too small. The diagram shown in dotted lines and superimposed on the first one was taken after the stop cock had been cleaned out.

The effect of slight piston leakage is shown in a recent test on a large Diesel engine. A diagram, Fig. 6, was taken with a rather light indicator having a somewhat worn piston, and immediately afterwards the diagram in Fig. 7 was taken from the same cylinder under exactly the same conditions with an exceptionally fine, strongly built instrument. When measured, the second diagram gave about seven pounds more m.e.p. than did the first one. This test was repeated several times to prove that the apparent variation in m.e.p. was due to difference in indicators and not to irregularities in the fuel pump, and in each case the results were the same.

In each of the foregoing examples of diagram error the error is due to mechanical faults in the indicator mechanism, but in nearly every case a superficial diagnosis would ascribe the error to malfunctioning of the engine. Interpretation of diagrams in terms of engine performance has received considerable attention, but the man in the engine room is likely to overlook the limitations of the indicator and its operating mechanism and assume that the diagram is a true picture of what is occurring within the cylinder. With a proper understanding of the probability of mechanical errors in the indicator mechanism, a more rational interpretation of the indicator diagram is possible.

The engineer should appreciate the possibilities of the indicator as a means of locating faults in the engine, but at the same time he should understand that interpretation of the diagram may not be correct. It is a common assumption that if the flow of fuel through the spray valve of an air-injection Diesel is insufficiently restricted, it will be blown into the cylinder too suddenly, causing too rapid combustion and considerable rise in pressure above compression pressure, and the indicator diagram would be expected to show this sudden pressure rise. That this is not always true is shown by Fig. 8, which shows a normal indicator diagram and Fig. 9 taken from the same cylinder under the same conditions

except that all the atomizer disks were removed from the spray valve. In the latter case the diagram obtained might be interpreted to show very slow admission of fuel, due to too much restriction in the oil flow path or too low spray air pressure. As a matter of fact the fuel is blown into the cylinder in an unsufficiently atomized condition, so that it cannot mix thoroughly with the air. As a result latter diagram presents about the same appearance as would be produced by a very much delayed opening of the spray valve. This indicates the possibility of a wrong diagnosis when a card of this sort is taken.

It would be impossible to cover all the various changes that will occur in character of diagram with changing conditions in the indicator or in the engine. Variations

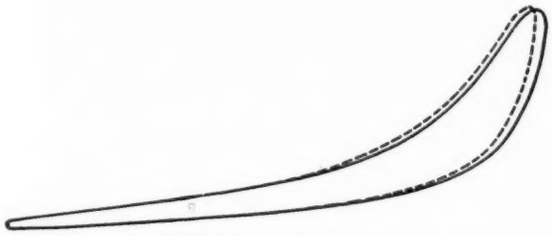


FIG. 2—EFFECT OF WEAK INDICATOR

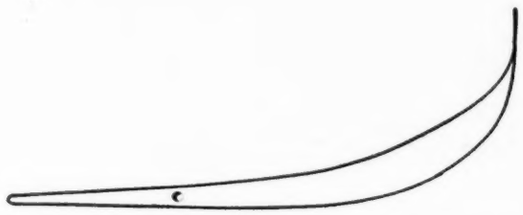


FIG. 3—DIAGRAM WHEN DRUM CORD STRETCHED

FIG. 4—WIRE CORD GAVE THIS DIAGRAM

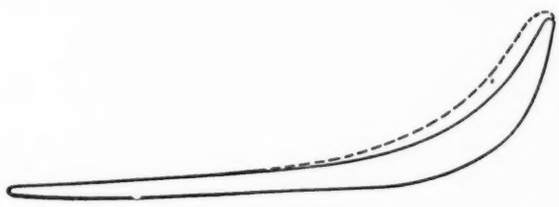


FIG. 5—EFFECT OF RESTRICTED GAS PASSAGE

FIG. 6—DIAGRAM WHEN INDICATOR PISTON LEAKED

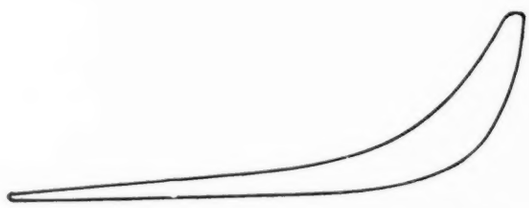


FIG. 7—CORRECT DIAGRAM WITH GOOD INDICATOR

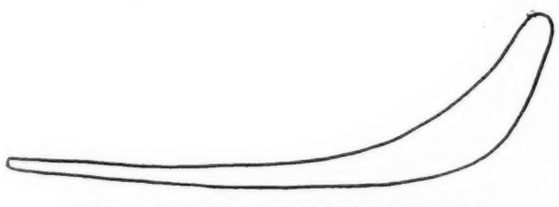


FIG. 8—NORMAL INDICATOR DIAGRAM

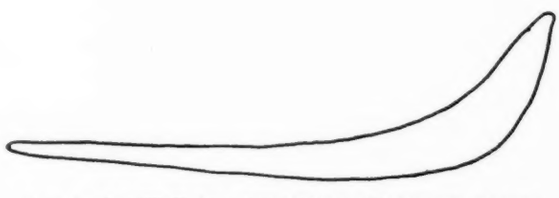


FIG. 9—RESULT OF REMOVING ATOMIZER DISKS

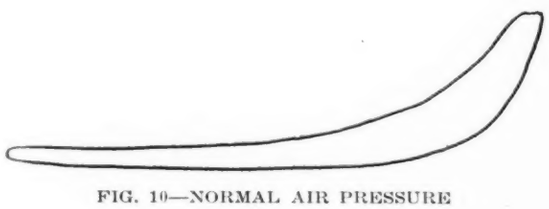


FIG. 10—NORMAL AIR PRESSURE

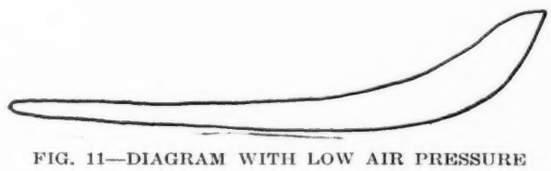
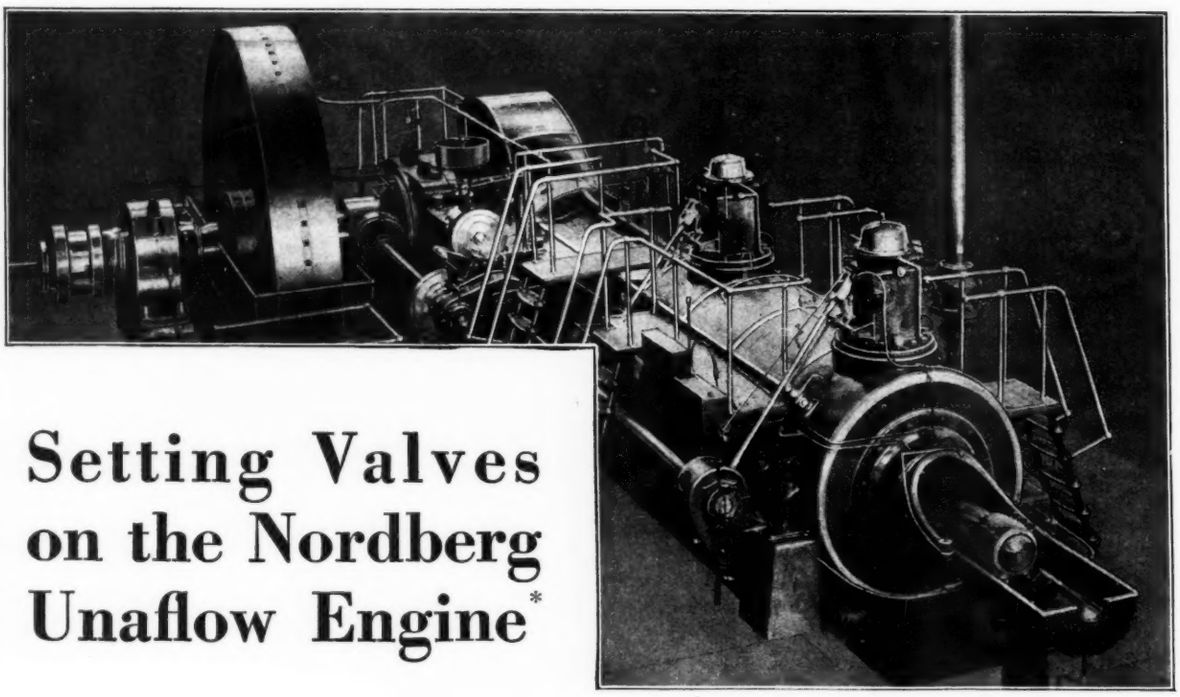


FIG. 11—DIAGRAM WITH LOW AIR PRESSURE

combustion is too slow, the combustion line droops, and the fuel is not completely burned until late in the stroke.

Figs. 10 and 11 show very clearly the effect produced in the indicator diagram by varying the spray air pressure. Cards were taken at every 50-lb. variation in pressure, but the two shown represent the extreme limits, 10 being taken when the air pressure was 850 lb. and 11 when it was 700 lb. It should be noted that the in fuel viscosity and temperature; valve timing, air pressure, spray-valve adjustment, engine speed, compression, condition of the indicator, etc., all affect the shape of the indicator diagram, but the few examples cited, which are reproductions of actual cards taken under operating conditions, indicate the sort of study that is required to be able to recognize the difference between the effects of these various influences.



Setting Valves on the Nordberg Unaflow Engine*

IT IS by no means unusual to hear statements made by eminent engineers that the unaflow engine is and must always be a machine of small power; that when a capacity over 500 to 750 hp. is required, the choice will be some other type of prime mover. Such opinions are contrary to actual facts for the number of unaflow engines above 500 hp. capacity is large and the sale of such engines is increasing. A great many engines of over 1,000 hp. are in service. A number of them of 1,000 to 10,000 hp. capacity have been installed in steel mills, where they are used to drive bar and sheet mills. One of these engines has a maximum capacity of 20,000 hp.

The Nordberg Unaflow design engine follows European practice in the use of a layshaft upon which the eccentrics are placed and which is driven by the crankshaft through bevel gears. The governor, which is of the centrifugal type, is supported on the layshaft and being connected to the steam eccentrics by a sleeve controls the engine speed by altering the eccentric travel and the lift of the steam valves. In the steel-mill engine the layshaft governor of the standard engine is replaced by a flyball governor driven from the layshaft by variable-speed friction wheels. As will be noticed in the headpiece, this requires a two-piece layshaft, but enables the engine to operate over an extremely wide range of speed. A cross-section of the standard Nordberg Unaflow cylinder is shown in Fig. 1.

An unusual feature of the valve design is the employment of cages in which the valves rest and which in turn fit into cavities in the heads, these cages being sealed by a ground joint and held down by the valve bonnet. In many engines there is a considerable difference in the expansion of the valve and of the cylinder casting in which it seats. If the valve is double-beat, as is almost imperative in order to avoid excessive lift this difference in expansion will cause leaks between the valve and one of the seats. By placing the valve in a cage that is made of metal from the same heat as the valve, the rates of expansion of the valve and seats are identical and leaks are eliminated. The valve and cage appear in Fig. 2.

To eliminate excessive compression pressure if the vacuum is lost when operating condensing, a positively operated auxiliary exhaust valve is placed at each end of the cylinder as outlined in Figs. 1 and 4.

Both steam and exhaust valves of the Nordberg-Todd unaflow engine are opened and closed by positive cam action. No springs or dashpots are used, except that the connection between the valve stem and the valve is flexible; this flexibility is furnished by a light spring which holds the valve against a lug turned on the end of the valve stem.

The steam valve, which has a bored recess, is guided by a pilot on the lower end of the cage. The other end of the stem is fastened to the crosshead, which is guided in the bonnet; this allows the stem to float in the stuffing box. The stem is made with labyrinth packing grooves which make a steamtight fit in the stuffing box.

The auxiliary exhaust valve is of the same general design except that the valve is inverted on the stem. Both steam and exhaust valves are operated by a cam lever *A* which is actuated by a cam *B*, the contacts being made by hardened steel rollers *C* and *E* working on hardened steel bushings. The operation of these valves is as follows:

As the eccentric rod *F* moves upward, the cam *B* is rotated inwardly. At the proper point in the engine stroke the cam contacts with the opening roller *E*. At the same time the back part of the cam *B*, which is

*This is the fifth of a series of articles on setting unaflow engine valves. The previous articles appeared in *Power*, Oct. 17, Oct. 24, Nov. 7 and Nov. 14. Others will follow.

depressed, comes under the closing roller *C*. Further upward movement of the steam reach rod *F* causes the cam to force the roller *E* upward, the cam lever *A* moving about the fulcrum pin *G*. The valve is lifted off its seats, admitting steam into the cylinder. The eccentric continues on around its circle, the rod *F* reverses its upward travel and moving downward causes the cam *B* to strike the roller *C* and so closes the valve. As the cam has a steep slope at the points of contact with the rollers *E* and *C*, the opening and closing of the

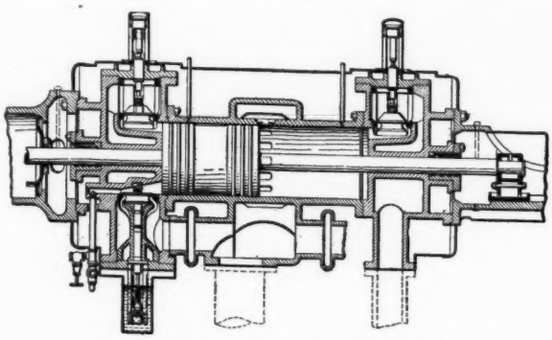


FIG. 1—CROSS-SECTION OF NORDBERG UNAFLOW

valves is rapid. After the valve seats, the further travel of the cam causes the valve stem to compress the valve spring, thereby insuring not only positive valve-closing, but also considerable downward pressure on the valve where it is seated. The cams carry two marks, one of which shows the exact point of closure of the valve, and the other shows the point where the connecting spring first comes under full compression, this compression being just sufficient to insure the valves being firmly seated on the cage. The fulcrum pin *D* of the cam is turned eccentric so that the cam can be adjusted with just the proper amount of clearance (about 0.003 in.) between the cams and rollers. This adjustment must be made accurately, but when once made there is no necessity for any change inasmuch as there is no wear on the cam or rollers. Care must be taken in adjusting the length of the valve stem so that the compression in the spring does not become excessive. To do this, the engine should be turned to a point where the valve is closed and the stem then adjusted so that the coils of the springs are not cramped together. The actual setting of the valves is accomplished by changing the length of the eccentric rod and the eccentrics in the

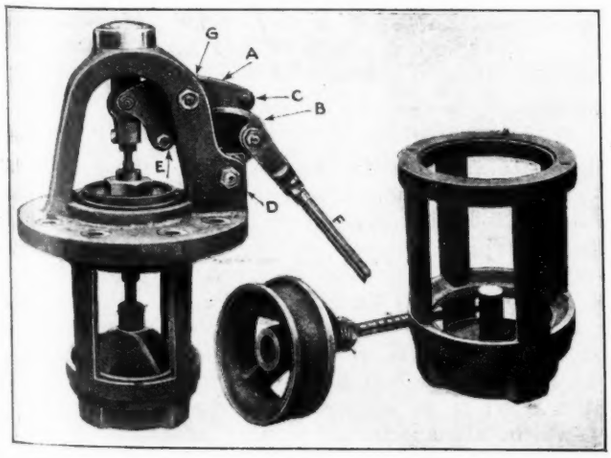


FIG. 2—DETAILS OF STEAM VALVE

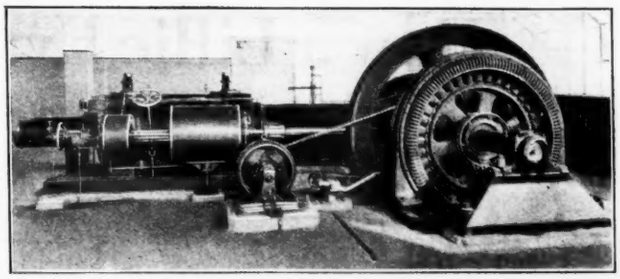


FIG. 3—NORDBERG DIRECT CONNECTED UNAFLOW

usual manner. The engine should be turned to dead center, and with the governor weights blocked to their overspeed positions the eccentric rod should be adjusted so that the valve is not lifted but remains seated; that is, the cam should clear the cam-lever roller *E*. One point that should be remembered is that the roller which opens the valve is *E*, the one next to the valve stem on the steam valve gear and the one away from the valve stem on the exhaust valve gear or *H*.

Auxiliary Exhaust Valves

To take care of operating condensing and non-condensing, the exhaust cam is made with exceptionally long contact faces so that when operating condensing the valve can be kept closed and the rollers kept in contact with the cam while the eccentric is giving the full stroke to the cam. The exact point of opening the exhaust valve is of no importance because it takes place while the piston is uncovering the central exhaust ports. The exhaust valve should open at a point after the central ports are uncovered and before the end of its stroke. The eccentrics are definitely located when the

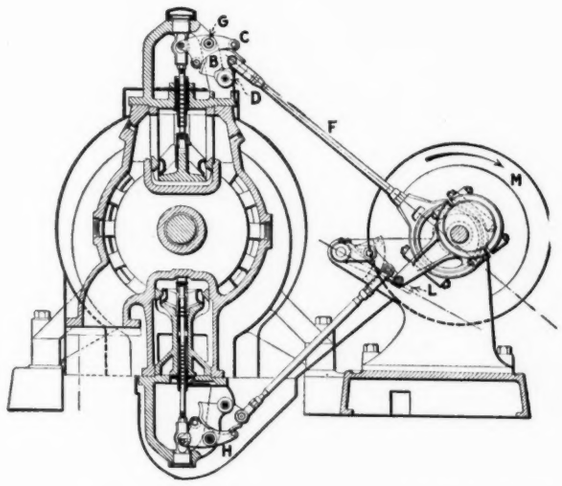


FIG. 4—STEAM AND AUXILIARY EXHAUST VALVES

engine is tested at the factory and no changes are necessary in the field. The point of closing the exhaust valves can be changed as desired by changing the effective length of the exhaust eccentric rods. This is done by introducing a combination lever *L* which is carried by a rocker arm, the rocker arms for both exhaust valves being adjusted by means of one hand lever. This adjustment can be made when the engine is in operation. By placing the hand lever in different positions, the point of closing the exhaust valve can be changed as desired to fit any operating condition.

How a Lillie Evaporator Operates

Sixth Article of the Series on Feed-Water Treatment—Operation of a Triple-Effect Evaporator That Operates On Exhaust Steam Is Given in Detail

WITHIN the last few years evaporators for supplying pure makeup feed water to stationary power-plant boilers have been attracting attention. For a long time evaporators were used on board ships, but it was only when the practice of forcing power-plant boilers to high ratings developed and the need for pure makeup water became imperative, that the evaporator was given serious consideration for stationary power-plant service. During the last seven or eight years a considerable number of installations of evaporators have been made in large power plants, and undoubtedly the next few years will see a greatly increased use of this apparatus, when its advantages in the power plants are better appreciated.

Scale formation, blow-down losses and foaming are all detrimental to efficient boiler operation and can be eliminated to a large degree by supplying pure feed-water makeup. Where boilers are operated at high ratings, it is absolutely essential that they be kept clean if burned tubes or more serious results are to be avoided.

The function of an evaporator in a power plant is to provide distilled water for boiler-feed makeup from raw water of whatever sort it may be. Evaporators may be divided into two classes—those that use exhaust steam to evaporate the raw water and those that use high-pressure steam. It is with one type of the former that the following description is concerned. The particular type is known as the Lillie multiple-effect evaporator and has been designed and developed by S. Morris Lillie, of Philadelphia, Pa.

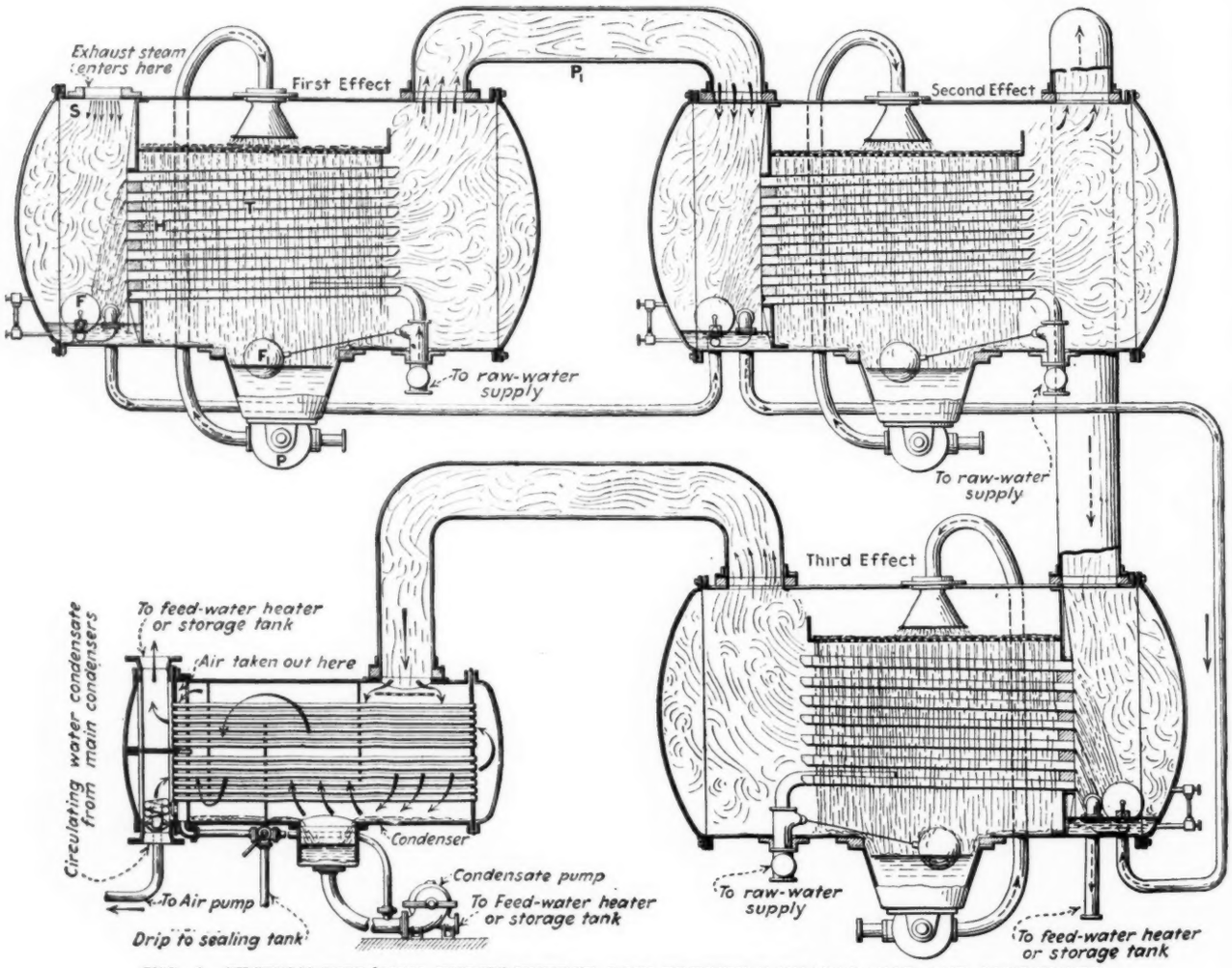


FIG. 1—SECTION THROUGH THREE-EFFECT LOW-PRESSURE EVAPORATOR AND CONDENSER

For power-plant work these evaporators are usually built in two or three effects, although for certain classes of work they have been built for as high as eight effects. Each effect is an evaporator in itself, the vapor end of which is connected to another effect or to a condenser. The latter would be the case with the last effect. In Fig. 1 is shown a section through a three-

effect evaporator and condenser. In practice these evaporators are so arranged that either one of the end effects can be made the hot effect; that is, exhaust steam would enter the effect on the left, and the vapor from this effect would pass into the next and be used to evaporate more water. This vapor would pass into the third effect and evaporate more water. From this effect the vapor goes to the condenser, where a vacuum of about 26 in. is maintained. In the reverse process, by closing suitable valves and opening others, the exhaust will go to the lower right-hand effect and the vapor from this effect pass into the middle section and the vapor from here into the effect on the left. From this effect the vapor would go to the condenser. The section that the exhaust steam enters is called the hot effect. Fig. 1 should not be considered as showing the piping connections complete, since the diagram has been developed to indicate the process, rather than to give mechanical details.

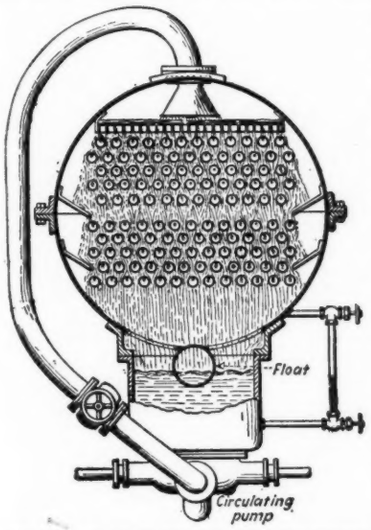


FIG. 2—CROSS-SECTION THROUGH EVAPORATOR AT RIGHT ANGLES TO THE TUBES

In the figure assume that the evaporator is in operation and that the left-hand section is the hot effect. Exhaust steam enters at the steam inlet S, fills this end of the evaporator and passes up into the tubes T, which have their right-hand ends closed except for a $\frac{1}{32}$-in. hole to prevent them from becoming airbound. These tubes are supported by the left-hand ends in a tube sheet H, and unsupported on the right-hand ends. The pump P takes raw water from the bottom of the evaporator and lifts it to the top of the effect, where it is delivered into a shallow pan having a large number of small holes in the bottom. From this pan the water pours in small streams down over the tubes and forms a thin film over them. For this reason the evaporating process in this type of evaporator is called film evaporation. Fig. 2 shows a section through one effect at right angle to the tubes, which clearly indicate how the water is distributed over them.

As the water passes down over the tubes, two things happen. The water takes up heat from steam in the tubes and is converted into vapor, which passes into the steam end of the next effect through pipe P_1. The steam, losing its heat in tubes T, is condensed into water and flows back into the bottom of the steam end. When the condensate reaches a certain height, float F opens a valve and the condensate flows into the steam end of the next effect. The pressure being lower in this effect than in the first, part of this condensate flashes into steam and combines with the vapor from the first effect and is used to evaporate raw water.

There will be a small quantity of air in the exhaust steam. This passes through a small hole in the end of each tube to the vapor end of the effect and passes with the vapor into the next effect. As the water is evaporated, the float F_1 opens the valve in the raw-water supply and maintains the level in the bottom of the effect at a predetermined height. When the raw water is evaporated, the impurities remain in the bottom of the effect and must be removed. This is done by having a small discharge or the circulating pump open so that the sediment or other matter left in the evaporator is disposed of as fast as it accumulates.

What takes place in the first effect also is the process in the second only at a somewhat lower pressure and temperature. The vapor from this effect passes into the steam end of the third effect, as also does the condensate. This condensate is composed of the condensated vapor and condensates from the first effect. The vapor from the second effect, along with the part of the condensate that flashes into vapor, is used to evaporate more water in the third effect, but at a lower pressure and temperature than in the second effect. The vapor from this effect, along with the air drawn through the holes in the ends of the tubes, passes into the condenser, where the former is converted into water and pumped to a storage tank or feed-water heater. Any air that comes into the condenser is taken away by a vacuum pump. The condensate from the last effect may go through a flash chamber into the condenser and be pumped away with the condensed vapors to the feed-water heater or storage tank. The pressure is high enough in the steam end of the last effect above that in the condenser to cause the water to flow into the latter through a flash chamber. All or part of the boiler-feed water may be used as circulating water in the condenser to condense the vapors.

The evaporation of raw water on the tube surfaces will cause incrustations to form on these parts. If these were allowed to continue to form, they would soon seriously interfere with the efficiency of evaporation. These incrustations are cracked off by reversing the evaporator; that is, what was used as the cold end is made the hot and vice versa. The expansion and contraction of the tubes cracks the incrustation, and the water flowing over them washes these solids off. This material drops to the bottom of the evaporator and is disposed of through a small opening on the discharge of the pump. These incrustations are broken up into such small pieces that they will pass off with the impurities in the raw water.

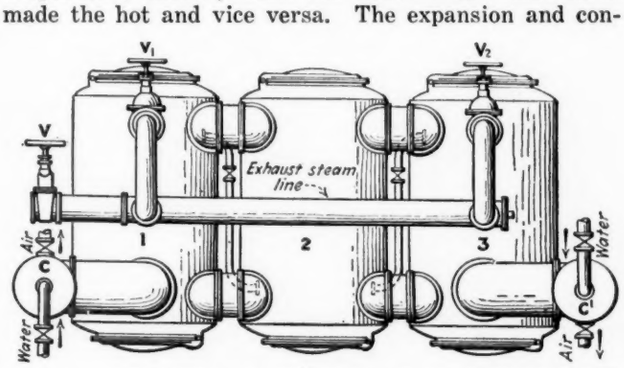


FIG. 3—PLAN VIEW OF ONE TYPE OF VAPOR-REVERSING TRIPLE-EFFECT EVAPORATOR

A plan view of one type of a vapor-reversing triple-effect evaporator is given in Fig. 3. When the hot effect is on the left, valve V_2 is closed and valves V and V_1 are open. Condenser C is allowed to fill with vapor and remain idle on the system, and condenser C' is put into service. With this arrangement steam enters

the steam end of the effect No. 1, and evaporation takes place in the different effects, as explained in Fig. 1. If valve V_1 is closed and V and V_2 opened, then 3 becomes the hot effect, and 1 the coldest effect. Exhaust steam goes into the steam end of effect No. 3, and evaporation takes effect in a reverse process from that described in Fig. 1. In this case condenser C' remains idle on the system and C is put into service. In Fig. 3 a jet condenser is shown connected to each of the end effects, which simplifies the vapor piping connections. Where a surface condenser is used, as in Fig. 1, the piping is generally arranged so that only one condenser is used.

In power plants, waste hot water such as boiler blowdown and hot drips may be taken into the evaporator and distilled. In this way a large percentage of the heat in this water is returned to the boilers. This water is evaporated and the impurities disposed of as in the case of raw water.

Of course, where distilled boiler-feed makeup water is used, the need for blowing down the boilers will be greatly reduced. However, impurities will get into the boilers owing to condenser leakage, and when they are blown down, if the hot water is passed to the evaporator, a large percentage of the heat is saved. The foregoing would also apply when a boiler must be emptied for inspection or repairs.

A subsequent article will describe a new model of the equipment that has been developed for distilled-water production.

Charts for Determining Stack Dimensions

BY R. A. FORESMAN
Chief Engineer, Stoker Division, Westinghouse Electric and Manufacturing Company

THE height and diameter of a stack may be determined by using the charts attached, so that calculations from the usual formulas are avoided. Results have been entirely satisfactory during the six months of commercial use of these charts, so that the large amount of time spent in placing the factors entering into stack determinations in a usable form has been well repaid.

Chart No. 1 is for boilers of less than 10,000 sq.ft. heating surface, while No. 2 is for the boilers of 10,000 and upward. Both charts contain notations of certain air and gas conditions that are assumed for basing these curves. It is necessary to know the amount of connected heating surface in square feet as well as the draft pressure required to carry the gases through the boilers and breechings. Any desired velocity of gases in the stacks may be used; the curves at B and C, Fig. 1, contain lines that represent the *economical stack velocity* as the average of commercial conditions indicates. The stack diameter, draft loss in stack and height of stack may be determined from curves C, D and E.

Example No. 1, as noted on chart No. 1, assumes that the evaporating surface of the boilers on the stack is 7,000 sq.ft., the draft loss being 0.75 in. of water for boilers and breechings, working at 150 per cent rated capacity. Find diameter and height at the economical velocity.

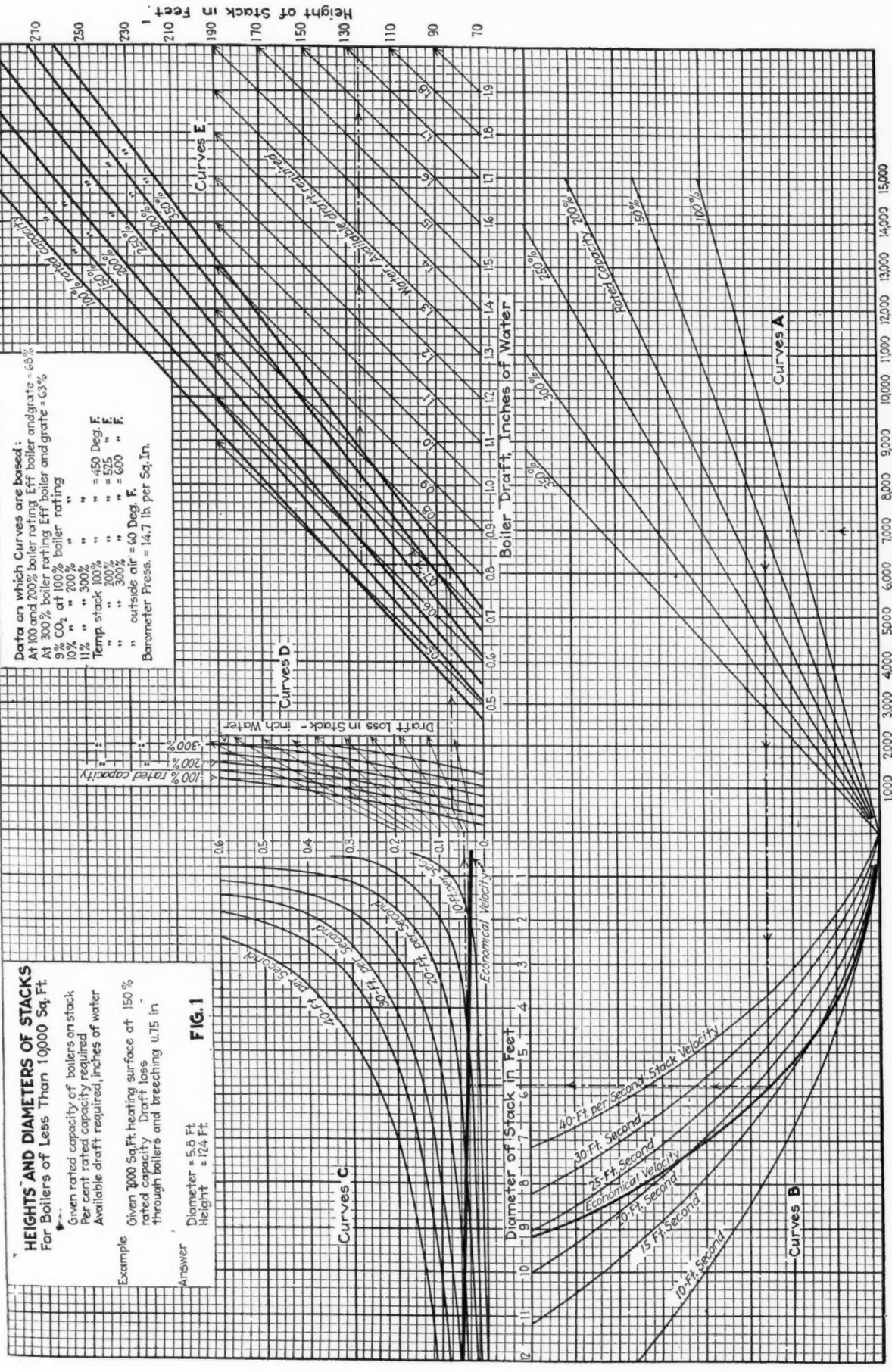
The chart indicates the line from curves A, starting at 7,000 sq.ft. heating surface and rising vertically to the 150 per cent rating line, moving horizontally from there to the curves at B, where the *economical velocity* is encountered. The stack diameter of 5.8 ft. is here indicated. Moving vertically, we come to the *same velocity* in curves C which is the line of *economical velocity*, and then move horizontally to curves D. After touching curves D at the vertical starting line, then move parallel to the inclined direction lines shown with arrowheads until the 150 per cent rating line is encountered. From this point move horizontally to the curves E, where a draft loss of 0.75 in. is obtained, which comes midway between inclined lines 0.7 and 0.8, noted by arrowheads. From this point rise vertically to the 150 per cent rating and read the stack height at the scale to the right, which in this case is 124 ft.

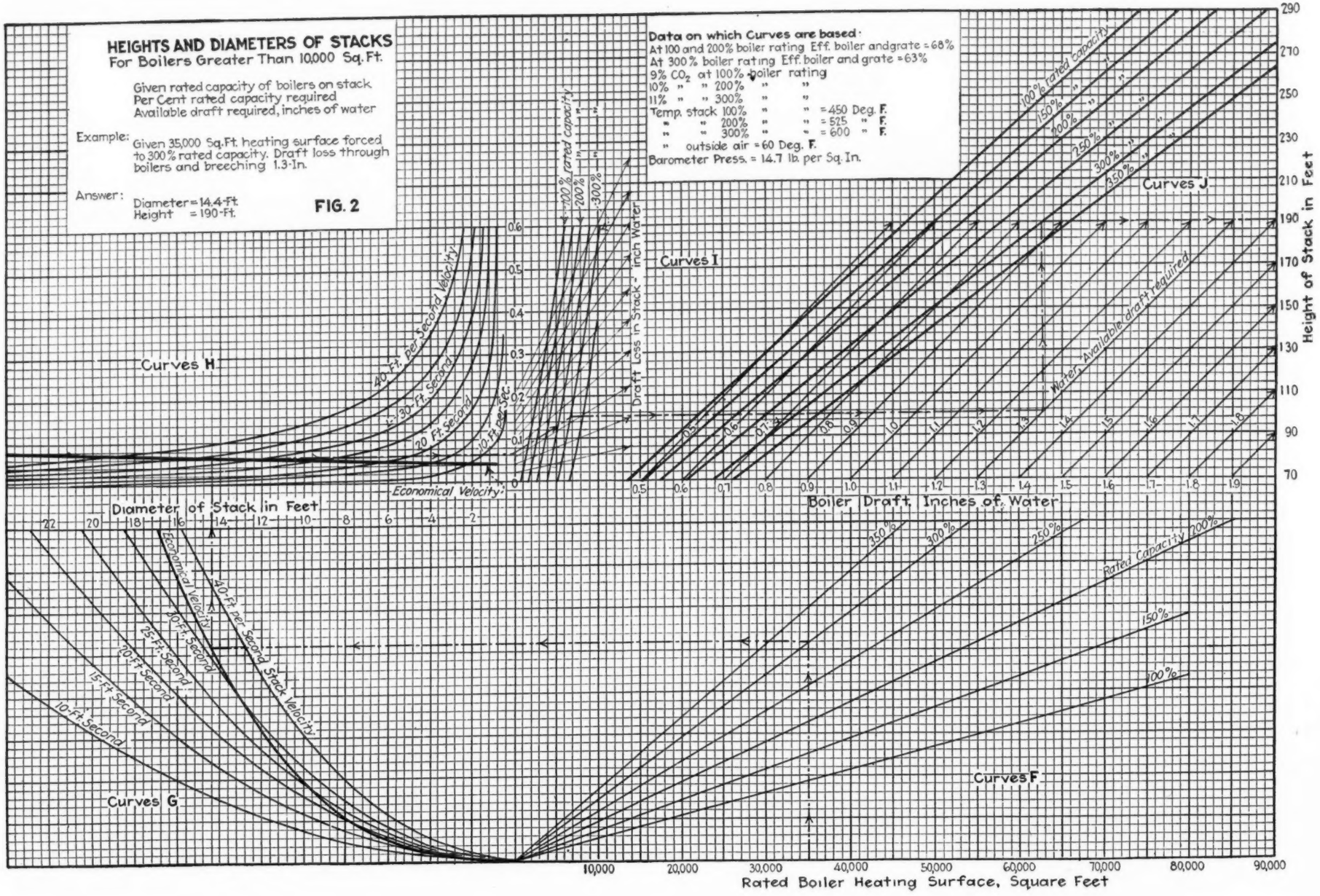
The draft caused by stack loss is shown at curves D. This is 0.045 in. of water. The total draft pressure required is the sum of this stack loss and 0.75 in. required for boiler breechings, which totals 0.795 in.

Example No. 2—Suppose it is required to carry 175 per cent rating on the same stack, how much would the stack height require to be increased, assuming that the draft pressure required for 175 per cent rating is 1.05 in. of water? Rising vertically from 7,000 sq.ft. to a point midway between the 150 per cent and 200 per cent rating lines, we then move horizontally to the same stack diameter as in example 1, which gives a velocity of 20 ft.sec. We then rise vertically to the 20 ft.sec. line, curves C, and move horizontally to the curves D of stack loss, which amounts to 0.06 in. Moving obliquely with the direction lines to 175 per cent rating, and then horizontally to a draft-pressure requirement of 1.05 in. which is obtained from the oblique line in curves E, we then rise vertically to the line of 175 per cent rating and obtain a stack height of 166 ft., read at the right. This would mean an increase in height of 166 minus 124, or 42 feet.

Example No. 3—Assume the same boilers and losses, at 150 per cent rating, what stack height and diameter would be required for a velocity of 25 ft.sec.? The diameter taken from curve B is 4.8 ft. The stack loss in this case is 0.115 in. from curves D. Using 150 per cent rating, we find that a stack height of 146 ft. is necessary.

Example No. 4—Suppose the same boilers were to be placed on a stack 6½ ft. in diameter and 230 ft. high and assuming that the loss of the boilers and breechings at various ratings varied as the square of the ratings, find the ratings to which the boiler may be forced. Taking a reading with 150 per cent rating and 0.75-in. draft pressure required for boilers and breechings, we find that a 6½-ft. stack gives 13.75 ft.sec. velocity, curves B, with a stack loss of 0.03 in. The stack height is 116 ft. Now, assuming a 200 per cent rating and a loss of boiler and breechings of 1.4 in., we obtain the *economical velocity*, which is 18 ft. per sec.; the loss in the stack is 0.045 in., and the stack height is 228 ft. The stack would, therefore, be satisfactory for 200 per cent rating.

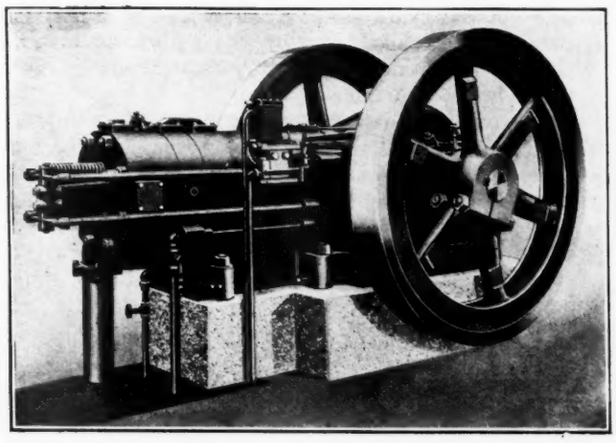

HEIGHTS AND DIAMETERS OF STACKS
For Boilers of Less Than 10,000 Sq. Ft.
Given rated capacity of boilers on stack
Per cent rated capacity required
Available draft required, inches of water
Example
Given 7000 Sq. Ft. heating surface at 150 % rated capacity. Draft loss through boilers and breeching 0.75 in.
Answer
Diameter = 5.8 Ft.
Height = 124 Ft.
FIG. 1
Data on which Curves are based:
At 100 and 200% boiler rating Eff boiler andgrate = 68%
At 300% boiler rating Eff boiler and grate = 63%
9% CO2 at 100% boiler rating
10% " " 200% " "
11% " " 300% " "
Temp. stack 100% " = 450 Deg. F.
" " 200% " = 525 " F.
" " 300% " = 600 " F.
" outside air = 60 Deg. F.
Barometer Press. = 14.7 lb. per Sq. In.
Curves E
Curves D
Curves C
Curves B
Curves A
Height of Stack in Feet
Boiler Draft, Inches of Water
Draft loss in Stack - Inch Water
Diameter of Stack in Feet
Rated Boiler Heating Surface, Square Feet
Rated Capacity
Economical Velocity
40-Ft. per Second Stack Velocity
30 Ft. Second
25 Ft. Second
20 Ft. Second
15 Ft. Second
10 Ft. Second


HEIGHTS AND DIAMETERS OF STACKS
For Boilers Greater Than 10,000 Sq. Ft.
Given rated capacity of boilers on stack
Per Cent rated capacity required
Available draft required, inches of water
Example: Given 35,000 Sq. Ft. heating surface forced to 300% rated capacity. Draft loss through boilers and breeching 1.3-In.
Answer: Diameter = 14.4-Ft.
Height = 190-Ft.
FIG. 2
Data on which Curves are based:
At 100 and 200% boiler rating Eff. boiler and grate = 68%
At 300% boiler rating Eff. boiler and grate = 63%
9% CO2 at 100% boiler rating
10% " " 200% " "
11% " " 300% " "
Temp. stack 100% " " = 450 Deg. F.
" " 200% " " = 525 " F.
" " 300% " " = 600 " F.
" outside air = 60 Deg. F.
Barometer Press. = 14.7 lb. per Sq. In.
Curves H
Curves I
Curves J
Curves G
Curves F
40-Ft. per Second Velocity
30-Ft. Second
20-Ft. Second
10-Ft. per Sec.
Economical Velocity
100% rated capacity
200%
300%
Draft Loss in Stack - Inch Water
Boiler Draft, Inches of Water
Water Available draft required
100% rated capacity
150%
200%
250%
300%
350%
Height of Stack in Feet
Diameter of Stack in Feet
Economical Velocity
40-Ft. per Second Stack Velocity
30-Ft. Second
25-Ft. Second
20-Ft. Second
15-Ft. Second
10-Ft. Second
Rated Capacity 200%
Rated Boiler Heating Surface, Square Feet

Why Lubrication of Gas Engines Is Difficult

By W. F. OSBORNE
Supervisor, Manufacturers' Service, Texas Company

Faulty cylinder lubrication is not always due to poor oil. Other and more prevailing causes are incomplete combustion, dust in the suction air and improper carburetion.



IN THE previous articles we have assumed that the fuel was completely vaporized and mixed with the correct amount of air before it entered the cylinder. We assumed further that it was completely burned at the proper time in the working cycle of the engine. Under such conditions the fuel itself could have little physical or chemical effect upon the oil.

Natural gas, illuminating gas, producer gas, and blast-furnace gas are perfectly vaporized fuels. It is possible to mix them thoroughly with the right amount of air, burn them completely in the cylinder and still get cylinder trouble. Such trouble would come from the dust carried in suspension in the gas or in the air. The tiny particles of grit stick to the oil film on the cylinder wall, and when the piston passes over the film the grit scratches and abrades the surface. This condition is likely to occur with any kind of fuel.

Imperfect Combustion

Slow burning and late burning of the fuel are hard on the oil film because of the greater exposure to severe temperatures. Lean mixtures and excessively rich mixtures cause trouble for the same reason, and many times it is possible to correct a bad lubricating situation by improving the combustion, which should have been done anyway.

When incomplete combustion occurs, smoke or soot is quite likely to be formed. If the soot is carried out through the exhaust, no harm is done except that the fuel consumption is needlessly high, but if there is present on the top of the piston or in the combustion chamber a thick film of oil, the soot, when blown against it, sticks and lays the foundation for a fine deposit. More oil working past the piston rings collects more soot, and the deposit rapidly builds up and begins to cause trouble.

If the soot were eliminated or if the oil were eliminated, there would be no deposit. The former can be taken care of by carefully adjusting the fuel mixture, the timing of the ignition, etc.; the latter, by using an oil that will evaporate quickly once it finds its way into the combustion space or by reducing the amount of oil getting past the piston rings. More carbon deposits are due to incomplete combustion than to all other causes combined.

When the carbon particles get loose from the metal, they may find their way into the piston clearance or are blown onto the oil film on the cylinder wall, where they are rubbed back and forth, causing the piston rings, piston and cylinder to wear out. It is not lack of enough oil or even of the right kind of oil that sends most of the pistons and cylinders to the scrap heap, but the cutting away of the metal by foreign matter.

Engines burning liquid fuel, including in this division all gasoline, kerosene and fuel-oil engines, whether of the carburetor or liquid-injection type, are susceptible to many other lubrication troubles. The carburetor is supposed to atomize and vaporize the liquid fuel so that, as it mixes with the air, it will form a homogenous mass of vapor prior to its entrance into the cylinder. In the old days when they burned 72 deg. Bé. gasoline, this was no doubt possible, but how many engines do you suppose are supplied with such vapor mixtures today?

The ordinary jet type of carburetor atomizes the fuel —gasoline or kerosene as the case may be—and after mixing it with air, delivers it to the cylinder in the form of a fog or mist. Unless the manifold is heated, it will be at a lower temperature than the surrounding air, due to the evaporation of the fuel in a partial vacuum, and some of the fuel will fail to vaporize and will reach the cylinder in a liquid state. This is quite likely to occur with excessively rich mixtures and in cold weather. Kerosene, on account of its high boiling point, is more susceptible to improper vaporization than gasoline. Test bottles connected to the ends of the intake manifold have collected liquid fuel, which was being carried along to the cylinders by the friction of the passage of the mixture.

Dilution of Lubricating Oil

When liquid fuel reaches the cylinder on the suction stroke, part of it vaporizes on coming in contact with the warm cylinder walls, but as there is seldom time for more than a small portion to evaporate, it is thrown out by momentum to the cylinder walls and, collecting in the space between the cylinder and piston above the top ring, is quickly forced out of the cylinder on the compression stroke. The liquid fuel and the lubricating oil are of course completely soluble. The absorption of liquid fuel of low viscosity reduces the viscosity of the oil and destroys its adhesiveness. It is no longer able to perform its duties of lubricating the cylinder and of assisting in the formation of a piston seal. The leakage of fuel is plainly seen on some horizontal engines burning kerosene, where it drips steadily from the open end of the cylinder.

Some oils will withstand the "washing effect" of liquid fuel better than others. Apparently, they do not absorb so much of it and maintain their original viscosity and adhesiveness longer. Generally speaking, a high-viscosity oil is thinned down to the danger point less quickly than a low-viscosity oil. This means that it takes more liquid

fuel to get the same final viscosity, and if a new film is consistently brought up by the piston, it is quite possible to maintain satisfactory lubrication in spite of the adverse conditions.

An improvement in lubrication, impaired by fuel absorption, can be secured sometimes by raising the temperature of the circulating water. This raises the cylinder temperature, improves the evaporation and combustion of the fuel and reduces the amount of fuel available for absorption by the oil. The air-cooled engine, because of its higher cylinder temperature, evaporates a greater amount of liquid fuel reaching the cylinder and there is less dilution or reduction in the viscosity of the oil.

Any method of improving the vaporization of the fuel before it reaches the cylinder is certainly a great advantage not only from the standpoint of lubrication, but also from that of fuel economy. Heating the intake manifold by the exhaust gases, heating the intake air or the fuel itself, or diluting the fuel mixture with hot exhaust gases, all benefit in so far as they prevent liquid fuel from reaching the cylinder. Instead of the high temperature of the fuel mixture having a bad effect on the oil film, the result is quite the reverse, even when the mixture is as hot as 600-700 deg. F., because the slight increase in evaporation due to the higher temperature is more than offset by the elimination of absorption of liquid fuel. Perfect vaporization of the fuel would obviate the necessity of maintaining the cylinder-wall temperature at a high degree to improve vaporization within the cylinder. Lubrication would be improved through the use of lower-viscosity oils for there would be lowered evaporation and less carbon deposits.

An Easy Way To Figure Steam-Pipe Sizes

By M. W. WARD
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THE first part of this article discusses the Babcock formula for the flow of steam in pipes. The author then develops a formula for the area required to transmit 100,000 B.t.u. per hour with a steam velocity of 8,000 feet per minute. The results are given in Table I. Readers who are interested only in the practical application of this simple method will find it explained and illustrated following the heading "How To Use the Tables."

THE engineer desiring to know the size of steam pipe required to deliver enough steam to the heating element of a water-heating device (such, for instance, as a storage-type heater with a steam-tube heating element) finds that considerable time and computation are necessary to secure the desired information from existing tables and formulas.

The most generally accepted formula for the flow of steam in pipes is due to Babcock, and is as follows:

Let W = Weight of steam flowing in pounds per minute;
P_1 = Initial pressure of steam in pounds per square inch;
P_2 = Final pressure of steam in pounds per square inch;
L = Length of pipe in feet;
d = Inside diameter of pipe in inches;
w = Density of steam in pounds per cubic foot.

Then

$$W = 87\sqrt{\frac{w(P_1-P_2)d^5}{L\left(1+\frac{3.6}{d}\right)}} \qquad (1)$$

$$P_1 - P_2 = 0.000132\left(1+\frac{3.6}{d}\right)\frac{W^2L}{wd^5} \qquad (2)$$

Since, in problems relating to water heating, we can easily find the amount of steam required, neither of the foregoing formulas is in the form we need, and by solving for d in (1) we have the formula,

$$d = 0.167\sqrt[5]{\frac{W^2L}{(P_1-P_2)w}\left(1+\frac{3.6}{d}\right)} \qquad (3)$$

This last formula is not readily solved without several trials and the use of logarithms or a table of fifth roots, or perhaps a log-log slide rule.

Various tables are published that give the weight of steam, in pounds per minute, flowing through different-sized pipes at different steam pressures. These tables are usually based on a stated pressure loss and a certain length of pipe; unfortunately, they are often seriously in error and, further, fail to give the source from which they are derived. Few engineers will make use of figures the derivation and accuracy of which are doubtful. Moreover, the use of such tables frequently gives velocities that are too high for this class of work.

Experience covering several hundred installations seems to show that when the pipe size is such as to give a maximum velocity to the steam of 8,000 ft. per min., the heater will operate satisfactorily and the pipe size will not be unreasonable.

In water-heating problems we usually have the following information given: Pounds or gallons of water

TABLE I—PIPE AREAS REQUIRED TO DELIVER 100,000 B.T.U. (LATENT HEAT) PER HOUR WITH A STEAM VELOCITY OF 8,000 FEET PER MINUTE

Steam Pressure, Lb. Gage	Pipe Area, Sq.In.	Steam Pressure, Lb. Gage	Pipe Area, Sq.In.	Steam Pressure, Lb. Gage	Pipe Area, Sq. In.
0	0.828	13	0.464	70	0.173
1	0.769	14	0.450	75	0.164
2	0.726	15	0.436	80	0.157
3	0.690	20	0.380	85	0.150
4	0.657	25	0.337	90	0.143
5	0.628	30	0.304	95	0.138
6	0.600	35	0.277	100	0.133
7	0.576	40	0.254	125	0.111
8	0.554	45	0.235	150	0.097
9	0.533	50	0.219	175	0.085
10	0.514	55	0.205	200	0.077
11	0.496	60	0.193	...	.....
12	0.480	65	0.182	...	.....

TABLE II—INSIDE DIAMETERS AND AREAS OF STANDARD PIPE

Nominal Size, In.	Inside Diameter, In.	Area, Sq.In.	Nominal Size In.	Inside Diameter, In.	Area, Sq.In.
¼	0.622	0.304	4½	4.506	15.947
⅜	0.824	0.533	5	5.047	20.006
1	1.049	0.864	6	6.065	28.890
1¼	1.380	1.496	7	7.023	38.738
1½	1.610	2.036	8	7.981	50.027
2	2.067	3.356	9	8.941	62.786
2½	2.469	4.788	10	10.020	78.854
3	3.068	7.393	11	11.000	95.033
3½	3.548	9.887	12	12.000	113.097
4	4.026	12.730			

per hour to be heated, the inlet and outlet temperature of the water, and the steam pressure to be used.

Let W = Pounds of water to be heated per hour;
R = Rise in temperature required in deg. F.;
L = The latent heat of steam at the given pressure;
w = Density, or weight in pounds per cubic foot, of steam at given pressure;
V = Velocity of steam in ft. per hr. (480,000 ft.);
A = Area of pipe in square inches;
S = Pounds of steam required per hour.

Then

$$S = \frac{W \times R}{L} \tag{4}$$

$$A = \frac{S}{w \times V} \times 144 \tag{5}$$

We can combine (4) and (5) as follows:

$$A = \left(\frac{\frac{W \times R}{L}}{w \times V}\right) 144 \tag{6}$$

Now if V remains constant, we can assign a unit value to the product of $W \times R$ and prepare a table of values of A for various steam pressures. Such a table will give ready means for solving all problems of this nature.

How to Use the Tables

Table I is based on a unit value of 100,000 B.t.u. for the product of $W \times R$, or the heat transmitted per hour, and a steam velocity of 8,000 ft. per min. (480,000 ft. per hour). For these conditions the formula reduces to:

$$A = 30 \div Lw \tag{7}$$

The following example will illuustrate the use of the tables: It is required to find the proper size of steam pipe for a storage heater with a capacity of 2,000 gal. of water per hour, heated from 50 deg. to 180 deg. F., using steam at five pounds gage pressure. From the table the area corresponding to five pounds is 0.628. Remembering that one gallon equals 8.33 lb., we get:

$$\textit{Required area} = 0.628 \times \left(\frac{2000 \times 8.33 \times (180 - 50)}{100{,}000}\right)$$

$$= 0.628 \times 21.658 = 13.60 \text{ sq.in.}$$

Turning to Table II, it is seen that a 4-in. standard pipe, with an area of 12.730 in., would be satisfactory.

Should a different steam velocity be required, the area corresponding to such velocity can be found as follows:

Suppose that the required velocity be 6,000 ft. per min. Then, since the tabulated values were figured for 8,000 ft. per min., it is only necessary to multiply the table value by 8,000 and divide by the required velocity. For example, if the area found for an 8,000-ft. velocity is 13.60 sq.in., then $\frac{13.60 \times 8000}{6{,}000} = 18.13$ sq.in. The nearest standard pipe would be five-inch.

As a rule, storage heaters, hot-water generators and converters are provided with a thermostatic valve to regulate the quantity of steam used to the hot-water demand. Contrary to general belief, this valve should be smaller than the pipe size used to convey the steam to the heater because (with velocities of 8,000 ft. per min. and less), if we should use a valve of the same size as the steam line, it would seldom open wide, but remain "cracked" a great part of the time. This would result in "wiredrawing," which in time would seriously injure the valve seats. A thermostatic valve with a flow area 60 per cent of that found for the pipe area from the table will give better service and last longer. It will open wide when steam is required, and close completely at times when there is little or no demand.

How to Ground Conduits

Some Peculiarities of Ground Connection—Precautions to Observe in Installation —Required Size of GroundWire—Forms of Ground Clamps

By EDGAR P. SLACK
Assistant Engineer, Underwriters' Laboratories

GROUND conductors differ from circuit wiring in that ordinarily they carry no current and do not affect the normal operation of the machines or equipment. Thus it follows that if by any chance the ground connection becomes broken or disconnected, this break may escape notice until the emergency arises for which the ground is depended upon to furnish protection. Furthermore, the ground wire is run in places not usual for circuit wires and is more subject to corrosion and mechanical injury than the circuit wires. For these reasons it is necessary to use special precautions in installing the ground connection.

The grounding of a metal-raceway system, including metallic conduit, armored cable and metal molding, consists briefly of connecting the raceway by a wire to a reliable ground. When such a system is being installed, care should be taken that all parts of the raceway are in good electrical connection with each other so that if a breakdown occurs and the raceway is called upon to carry a heavy current, high-resistance joints will not be encountered. High-resistance joints will reduce the protection against shock for which the grounding was provided and will also be likely to overheat the joint, numerous fires having resulted from this cause. Thus, if conduit, couplings or fittings having protective coating of non-conducting material, such as enamel, are used, it is required that this coating shall be thoroughly removed from the threads of both couplings and conduit. The armor of conduits, cables and other metal raceways must be securely fastened in outlet boxes, junction boxes and cabinets, so as to secure good electrical connection, or the separate sections, raceways, boxes and cabinets must be separately grounded.

The ground connection for conduit or other raceways should be as near as practicable to the point where the conductors in the system receive their supply and should be made with an approved ground clamp having a solder lug (or approved solderless connector) for the ground wire. The point of attachment should be such that both the connection and the ground wire are protected from injury and still are accessible for inspection by the electrician or the inspector; paint or enamel should be

scraped off to insure good electrical contact, and the job made thoroughly substantial and mechanically sound.

The size of ground wire is determined by the size of the circuit wires inside of the raceway to be grounded. The Code requires that "the ground conductors must be at least equivalent to No. 10 B. & S. gage copper (where the largest wire contained is not greater than No. 0 B. & S. gage), and need not be greater than No. 4 B. & S. gage (where the largest wire contained is greater than No. 0 B. & S. gage), and for service conduit the ground shall not be less than No. 8 B. & S. gage copper." Disregarding the service conduit, this rule is generally interpreted as requiring a No. 10 B. & S. gage ground wire for interior raceways if the largest wire contained is No. 0 B. & S. gage or smaller, or a No. 4 B. & S. gage ground wire if the largest wire contained is No. 00 B. & S. gage or larger.

It will be noted that no ground wire smaller than No. 10 is permitted in any case, as smaller wires would be more subject to mechanical injury, possible burnout and the effects of corrosion, and also because a low resistance is necessary to afford the desired degree of protection. For heavier circuits the current flow to ground in case of breakdown may be greater, and a larger ground wire is therefore used to guard against overheating and also to reduce the voltage drop and thus maintain the desired protection.

The ground wire should be of the same quality as the circuit wires, and it should be installed with all the

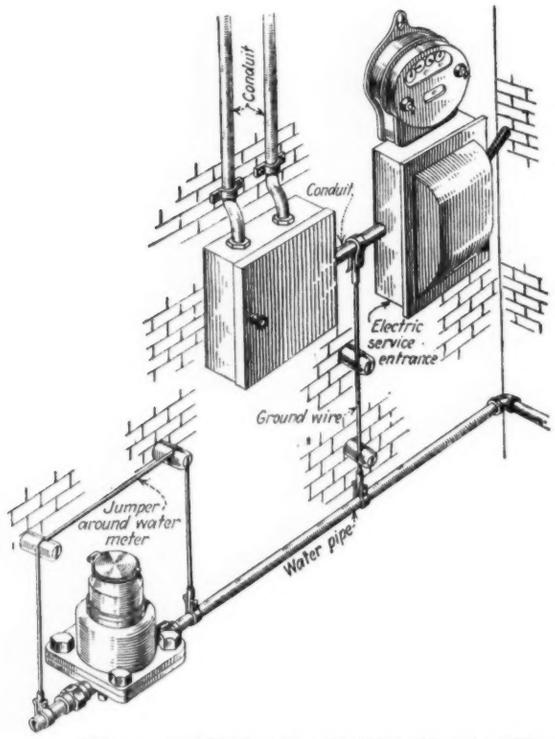
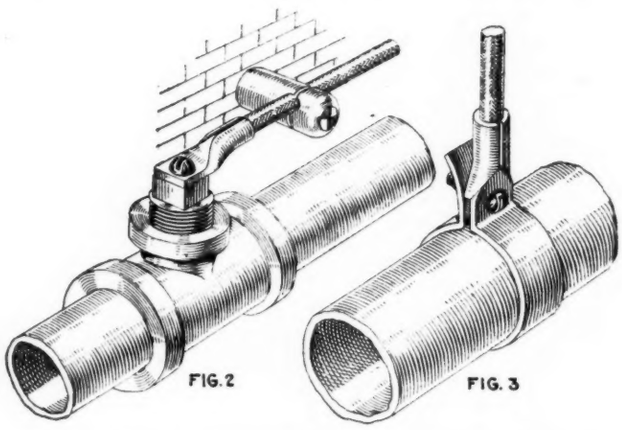


FIG. 1—METHOD OF GROUNDING ELECTRIC CONDUITS TO WATER PIPES

precautions that would be taken if it were alive. This is so that workmen and others will recognize it as an electric conductor and not injure or disconnect it and thus defeat its purpose. Also, in an emergency the ground wire may be called upon to carry a heavy current, large enough to overheat it seriously, and if it is carefully installed and spaced from woodwork, the likelihood of fire is reduced.

The other end of the ground wire should be connected to a good ground, a water pipe leading to an underground water system being preferred on account of its permanence and large current-carrying capacity. In the case of ground wires for raceways and motor frames the connection need not be made to the street side of the meter, but the ground wire may be connected to any convenient point on the water pipe, provided a jumper wire is shunted around the water meter,



FIGS. 2 AND 3—METHODS OF CONNECTING GROUND WIRES TO WATER PIPES

as in Fig. 1, to preserve the ground connection if the meter should be removed.

The connection to the water pipe is the most important part of the installation, as it is particularly subject to removal, corrosion, mechanical injury and loose contact. The point of connection should preferably be in plain sight and as readily accessible as possible. One of the most satisfactory connections is made by screwing tightly into a pipe fitting a brass plug having a solder lug for the ground wire, as in Fig. 2. There are also several common forms of approved ground clamps which may be used, one of which is shown in Fig. 3. With all such clamps the pipe should be carefully scraped free from rust or scale and the connection firmly and solidly made. The ground clamp should be regularly inspected and tightened after standing, to take up stretching of the soft copper band and loosening caused by expansion.

If the system consists of several separate sections of armored cable, conduit or other metal raceway, the sections should be bonded to each other and the system grounded, or each section may be separately grounded. In bonding sections together, ground clamps are employed and the wire sizes and installation methods are the same as described for the main ground connection.

Oil is sold in units of volume rather than weight, the unit being the barrel of 42 U. S. gal. As the volume of a given weight of oil varies considerably with the temperature, this volume must be based on a definite temperature, which is usually 60 deg. F. This is an important point to remember, particularly when checking quantity by gaging the tanks, for the temperature at which oil, particularly the heavier grades, is handled may easily cause an error of 5 per cent or more, generally making the quantity appear greater than the true figure. A much more logical way to sell oil would be by weight, using the ton as a unit.—*American Fuels.*

EDITORIALS

A Glimpse into the Power Plant Industry

IF THE demand for power can be taken as an index to industrial activities, the present outlook is most promising.

According to the latest monthly reports of the United States Geological Survey, compiled from actual returns of central-station companies, the demand is increasing steadily, with the curve pointing sharply upward; in fact, the output for the last nine months was fifteen per cent above that for a like period for 1921 and thirty per cent over that of 1919.

This demand is reflected in the large number of central stations under construction and additions to existing plants. There are now under construction or being installed, approximately 1,200,000 kilowatts in large turbo-generators. This figure is exclusive of the ultimate capacity of the new plants for which equipment contracts have not yet been let. Assuming an average price of twenty dollars per kilowatt, this represents an expenditure of twenty-four million dollars for turbo-generators alone. However, each prime mover entails other plant equipment, and assuming a total plant cost of one hundred and twenty-five dollars per kilowatt (both new plants and additions considered), this would involve an outlay of one hundred and fifty million dollars.

The foregoing is for steam plants of central stations alone. When hydro-electric plants are included, the figures grow to amazing proportions. Of the twenty million horsepower involved in applications before the Federal Power Commission, over three million has been approved and represents developments upon which construction has been or is about to be started. At two hundred dollars per horsepower this represents an investment of between six and seven hundred million dollars.

Unfortunately, the figures for private plants are incomplete and the latest Census returns are now two years old. However, according to these returns the growth in primary power of industrial plants alone for the ten-year period preceding the compilation, increased at the rate of over a million horsepower a year. This is exclusive of plants in office buildings, hotels, etc., and represents an annual expenditure of over one hundred million dollars.

Thus, considering both central stations and private plants there is represented an immediate expenditure of close to a billion dollars. The fact must not be overlooked that this is primary power alone and each kilowatt of primary power that is installed, involves the purchase of equipment for the transmission and application of this power, also a considerable expenditure in supplies and renewable equipment as contrasted with permanent installations.

Such figures awaken one to a realization of the tremendous business involved directly in the power-plant field, not to mention that indirectly depending upon the greater application of power.

The Electric Boiler Has Made Big Advancement

A FEW years ago when the electric steam boiler was first installed in Europe, many predicted that there might be a field for it in sections where there was an abundance of water power and coal was scarce and expensive, as in Norway and Sweden and the sections around the Alps and Pyrenees. However, the possibilities for this apparatus in this country, where fuel was comparatively cheap, were considered doubtful. Coal is no longer cheap as we used to understand this term, at least delivered in the bunker, and this undoubtedly has stimulated interest in the electric steam boiler where hydro-electric power is available.

Although within the last two or three years many engineers in this country have been reluctant to consider this class of equipment a factor in steam generation, it has reached a point in its development where there is installed or under construction in this country and Canada about two hundred thousand kilowatts normal capacity. This is equivalent to the evaporation of about seven hundred thousand pounds of water per hour from and at two hundred and twelve degrees Fahrenheit. The size of this equipment varies from less than one hundred kilowatts to two units each of twenty-five thousand kilowatts, or about equivalent to the normal rating of the largest fuel-fired boilers in use. One of the largest units, that with a normal rating of twenty-five thousand kilowatts, has absorbed as high as thirty-three thousand kilowatts. In size the average unit is large. For nineteen installations the average size of boiler is over nine thousand kilowatts. Although the electric steam boiler may still be in the development stage, these figures show that it is no longer an experiment even though the total capacity installed is very small compared with the capacity of fuel-fired boilers in use.

It is difficult to foretell what the future may hold for this class of apparatus, but undoubtedly economic reasons will restrict its use principally to localities where there is an abundance of cheap water power. Present developments would lead to this conclusion, since seventy-five per cent of the capacity in important installations is supplied from the Niagara and St. Lawrence power stations with about sixty per cent of the total in the Province of Quebec, Canada.

Where central-station or industrial hydro-electric plants have an excess of power, the electric boiler offers an excellent opportunity to utilize this surplus. It costs little more to operate the hydro-electric plant at one hundred per cent load factor than at fifty per cent, so that anything that will assist in raising the load factor will result in reducing the cost per unit of energy.

Where power is purchased by yearly contract on a demand basis and steam is produced by fuel-fired boilers, the electric boilers offer a means of producing steam cheaply by absorbing the off-peak energy and thereby reducing the coal consumption. During high-water

periods on some hydro-electric systems, it may be economical to install electric boilers in industries to absorb the excess energy, and operate fuel-fired boilers during low-water periods. A careful study of the field for the electric boiler will undoubtedly show many possibilities, but like most every other piece of industrial equipment, it must compete on an economical and service basis with other means of accomplishing the same end.

Importance of Properly Installing Turbo-Generator Sets

RELIABILITY depends primarily on proper design and manufacture. The operating engineer appears to carry the burden of responsibility from this point onward, but a consideration of the factors involved indicates that the installing, adjusting and placing in service of a turbo-generator of one hundred and fifty to five thousand kilowatts, such as the average manufacturing plant requires, is the really critical point in the life of the unit.

With years of manufacturing and operating experience to look back upon and turbine types well standardized, defects in design and workmanship have had ample time to make their presence known and consequently to be eliminated. Vibration, unbalance, misalignment, bearing troubles, etc., can now be corrected without difficulty where turbines have been in production for a long period.

A turbo-generator that operates well in the plant usually inspires a feeling of pride on the part of operators and receives its full share of interest and attention. On the other hand, comparatively little attention is required for the ordinary turbine while running. This is essentially a simple machine with thoroughly automatic lubricating and governing mechanisms. If the supply of cooling water is watched, little else is required. The condensing plant ordinarily demands much more attention from the engineer than the turbine unit and the requirements of such apparatus usually serve to make the operator's presence necessary in the vicinity of the latter. Special adjustments of clearances, governor regulation, etc., usually fall to the lot of the manufacturer.

Responsible care is required in starting up a unit and in properly inspecting the oiling system and automatic parts. Prevention of water or scale-forming impurities from entering with the steam is undoubtedly important, but turbine operation in general is not of such a character as to tax the skill of the average operating engineer.

Installing and placing in service turbo-generators of the sizes before mentioned, usually involve aligning and a certain amount of assembling as well as checking adjustments made at the factory. In addition, the conditions of operating at the plant are seldom those of test in the factory, so that further adjustments or minor changes are often necessary.

Strains due to steam and exhaust piping must be avoided; in a new plant there is a further handicap due to the boilers and condensers often being placed in service at the same time as the turbine, so that seriously abnormal steam and exhaust conditions are at times encountered. Proper alignment, grouting and adjustment require accurate, painstaking work; the purchaser in nine cases out of ten is behind the scheduled time for beginning operation, and delays are severely discountenanced, thereby adding to the erector's difficulties.

So much for the actual work of placing in service, which may be negligible in a small set and yet require several months in a large turbo-generator. The responsibility for acceptance of the unit rests upon the erector, and involves possible slips in factory work, so that an instance may arise where major factory operations must be corrected in the plant. The turbine unit must be left in correct adjustment, in which condition it will ordinarily maintain itself for a long period with a small amount of reasonable care. This responsibility which accompanies the process of placing the machine in service, makes this step the most important in relation to reliability.

Permanent Coal Commission Needed

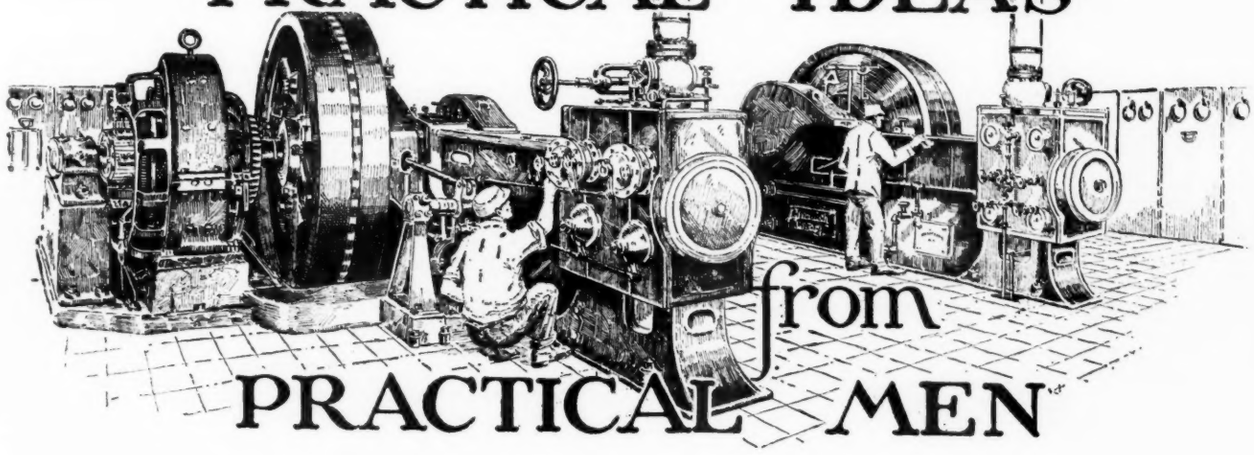
IT MIGHT seem extravagant to spend $200,000 a year continuously to support a permanent coal commission, yet it is claimed by John E. Orchard, Instructor in Economic Geography at Columbia University, that this expenditure would be an insignificant fraction of the saving such a body could effect. In an article in a recent issue of the *New York Evening Post*, Mr. Orchard referred to the Fact Finding Coal Commission (created Oct. 10) as an excellent body, with a membership calculated to inspire confidence in the thoroughness of its investigations and the soundness of its conclusions. He said, however, that its usefulness is curtailed by the fact that the life of the commission was limited by Congress to one year from the date of the enactment of the law creating it.

As a nation we have been strong for investigations after the barn is burned or the horse is stolen, but have not taken enough interest in preventive measures. It does us little good to learn the causes of our past and present troubles in mining and distributing coal if we do not take steps to cure the old troubles and prevent repetition of the old disasters. What would people think of a town that had no regular fire department, but organized a temporary one after each big disaster to investigate, report and then disband until after the next big fire? The parting advice of such a body would doubtless be cherished as a thing of some value, but it could hardly take the place of a fire department on the job all the time to bring dangerous conditions to light and nip disaster in the bud.

A one-year Fact Finding Commission is a fine thing as far as it goes, but why not have a permanent commission as Mr. Orchard suggests? It certainly cannot be argued that an industry best described by the word "chaos" is fully competent to look out for itself. Something is fundamentally wrong when the producing capacity is sixty per cent greater than the normal demand and the three-day week alternates with periods of shortage and extortionate prices.

There is, perhaps, reasonable ground for differences of opinion as to the proper powers and duties of a coal commission. Some, believing in the maximum freedom of individual initiative, will favor the present limitation to fact-finding activities. Others, knowing the present condition of the industry and its fundamental importance as the basis of industrial prosperity, will feel the necessity for broader powers. But there can hardly be any argument when it comes to choosing between a permanent commission and one that must pass out of existence before it is fairly started in its work.

PRACTICAL IDEAS from PRACTICAL MEN



A Rebabbitting Experience With a Pipe Mandrel

A recent experience I had in rebabbitting a quarter-box of a bearing may be of interest to other readers of *Power*.

A large blower furnishing air for a copper blast furnace ran hot on one bearing, and before it was discovered the babbitt was melted from one-half of the quarter-box, the other half being left intact.

I decided to restore the melted half by turning a mandrel the size of the shaft and clamping it firmly to the good half of the box and repouring the babbitt. Accordingly, a piece of 10-in. pipe 3½ ft. long was put in the lathe and turned to the right size and then clamped to the good half of the bearing. The whole was then placed in a convenient position and properly lined up, and the babbitt was run in. When the bearing had cooled off and had been cleaned up with a scraper, I checked it for high spots by putting lampblack on the mandrel and revolving it in the bearing. Much to my surprise it touched only on the two extreme ends and was open fully ⅛ in. at the center. I concluded this to be caused by the hot babbitt coming in contact with only one side of the pipe, causing it to expand and bow in the center. It was then necessary to bolt the bearing to the carriage of the lathe and bore it out with a boring bar.

FRANK AVIS.

Clemenceau Ariz.

What Is the Best Design of Firebox?

Considering the boiler-room situation—which is, really, the bunghole of our expenses, coal being the largest single item of expense—no criticism can be leveled at the boiler manufacturers for not building good boilers. Unfortunately, they have spent all their engineering talent in designing the boiler and have left it to the power-plant folks to arrange for a fire somewhere under the thing so it will boil the water and make steam. They seem not to have given a thought as to how much coal it will take to make steam, nor how inconvenient it may be to fire the boilers. Just so long as they provide a little space in which coal can be thrown, it would seem that they feel that they have done all that is necessary, whereas they have only accomplished the obvious—that is, provided a place in which to build a fire.

In so far as the referred-to bunghole of expense has its origin under the boilers where the coal is actually consumed, is it not a logical place or point to which to give a vast amount of attention? Naturally, it brings up the question, What is the best design of firebox? Of course this question pertains to the horizontal return-tubular type of boilers such as are used in the little fellow's plant.

Is it necessary for us to keep on building our fireboxes under the boilers? Why not place them alongside of the boilers, where they can be designed without regard to the boiler setting? Why not build them out there where we can give them the most efficient design possible—make them any shape that will give the best results? But the whole idea is to treat it as a separate and distinct piece of equipment, just as the engine is separate from the generator but they must work together.

With the firebox placed on the outside—a thing separate and apart from the boiler—we would have other advantages too: We would be able to bring the boiler down on a level with the fireman; the water and steam gages would be where they would be accessible and visible; the cost of the boiler setting would be greatly simplified and reduced; we would entirely eliminate the blistering or bulging of the boiler shell with its attendent expenses and loss of service; we would be enabled to insulate the boilers to an extent never before even dreamed of; we could cover them completely with asbestos or other material such as used to insulate steam pipes. All these advantages, however, are but incidental to the real advantages to be gained—that is, an efficient furnace in which to generate the heat from the coal—and the heat so generated could then easily be carried through suitable flues or firebrick masonry to the rear of the boiler, where it would give up its heat as under the present and inefficient conditions that are imposed by the old-time boiler setting.

The boiler manufacturers would do well to think a little more about producing more effective and steam-making heat. Of course I know there are many devices on the market that are to be used to improve conditions, but they treat the effect, not the cause. The manufacturer should be able to tell us what is the best design of firebox without regard to the boiler setting. Let the boiler setting lend itself to the firebox conditions.

Union Springs, Ala. C. R. HODGSON.

Changing from Two- to Three-Phase by Changing Coil Pitch

We recently had in the shop a motor that the customer had bought up cheap and wanted it changed from two- to three-phase. The original rating of the motor was 40-hp. 400-volt two-phase 25-cycle six-pole 480-r.p.m. squirrel-cage type, and it was to be changed to 40-hp. 440-volt three-phase 25-cycle six-pole. The stator had 144 slots and coils, two-layer diamond-shape winding in open slot. Each coil consisted of three turns of $\frac{1}{16}$x$\frac{1}{2}$-in. copper strap, pitch of coils 1 and 23, 6 groups of 12 coils in series, in each phase, or 216 turns, in series.

With the same turns per coil and pitch the three-phase voltage per phase would be $\frac{400 \times 2 \times 0.955}{3 \times 0.90}$ = 282.94 volts; then for a series-star connection the winding would be good for 282.94 × 1.73 = 489.5 volts. This is too high for 440-volt operation. If the motor was operated on a 440-volt line, it would be working at 11.36 per cent under voltage.

The coils were all made of strap copper, and the insulation was in good condition. It would be an expensive undertaking to make up a new set of coils with the proper number of turns. The next thing to check was the coil pitch, to see if it could be changed to give the required voltage. The two-phase coil pitch was 1 and 23; full pitch equals 144 ÷ 6 = 24 slots, or 1 and 25. When a coil spreads full pitch, it is considered as spanning 180 deg., so that on the machine in question each slot is equal to a span of 180 ÷ 24, or 7.5 deg.

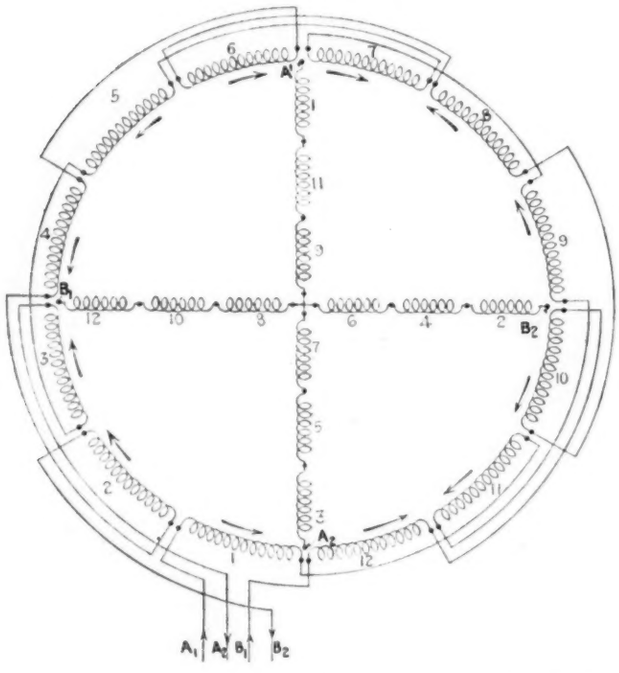


FIG. 1—DIAGRAM OF TWO-PHASE SIX-POLE SERIES CONNECTED WINDING

With the coils in slots 1 and 23 they span 22, or 22 × 7.5 = 165 deg. From the table the chord factor is found to be between 0.996 and 0.985, or about 0.99. A chord factor is required that will reduce the effective turns 11.36 per cent. New chord factor equals 440 ÷ 489.5 = 0.898, and from the table it is found that a coil spread of 130 deg. has a chord factor of 0.906, which is close enough to the required value. A span of 130 deg. equals 130 ÷ 7.5 = 17.3 slots, so the coils will be spread 1 and 18, or 5 slots less than the two-phase pitch.

Lifting up about thirty top halves of coils and removing four coils completely, we were able to spring two coils

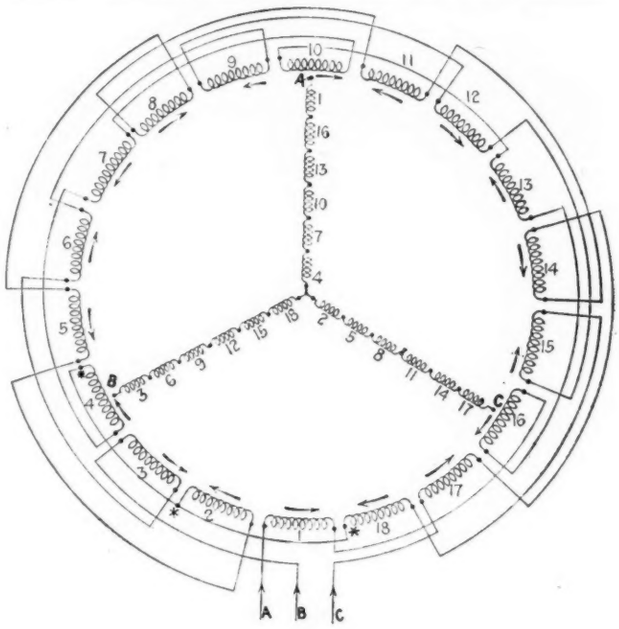


FIG. 2—DIAGRAM OF THREE-PHASE SIX-POLE SERIES-STAR CONNECTED WINDING

back to the 1 and 18 pitch; this made them extend about one inch on either side beyond the coils pitched 1 and 23. Trying on the end bells, it was found that there was a good two inches of clearance between the coil ends and the bearing brackets.

All the coils were carefully removed from the stator and pulled in the coil-pulling machine to the proper angle and at the same time given a little more kick-up; that is, increasing the distance the coil ends dropped below

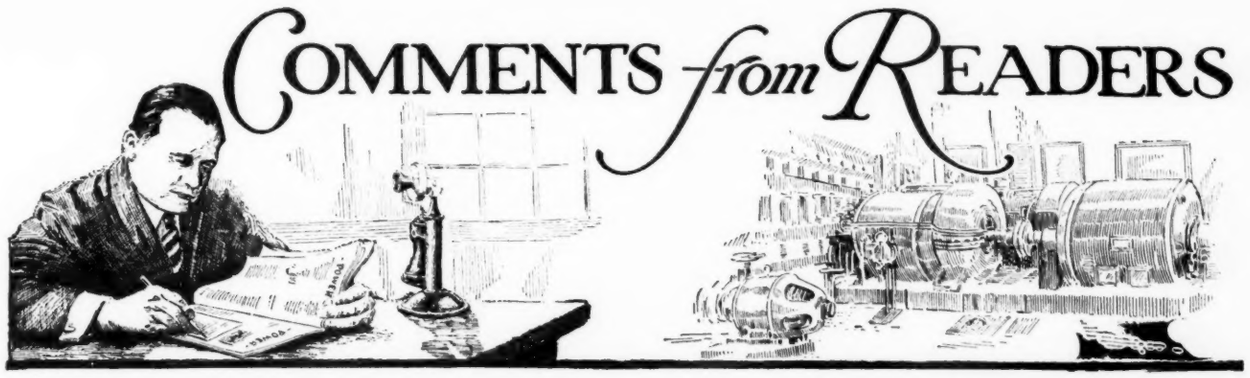
CHORD FACTOR CORRESPONDING TO COIL PITCH IN DEGREES

Pitch of Coil In Deg.	Chord Factor	Pitch of Coil In Deg.	Chord Factor
180	1.00	130	0.906
170	0.996	120	0.866
160	0.985	110	0.819
150	0.966	100	0.766
140	0.940	90	0.707

the level of the stator core. After the coils were reshaped, they were given a test for short circuits and then dipped and baked in a clear baking varnish; this filled up any cracks, etc., due to bending.

The coils per pole per phase equals the total number of coils divided by the number of poles times the number of phase, or for the two-phase winding 144 ÷ (6 × 2) = 12 and in the three-phase winding 144 ÷ (6 × 3) = 8 coils. In the two-phase winding there were 12 groups of coils, therefore there were 24 phase coils, one on each side of each group. In the three-phase winding there will be 18 groups and with a coil on each side of each group with extra insulation this will give 36 phase coils; therefore, in the new winding it was necessary to reinsulate 12 coils as phase coils. The stator was rewound with a pitch of 1 and 18, with 18 groups, 8 coils in series per group and connected series-star, as in Fig. 2.

A. C. ROE, Shop Supt.,
Detroit, Mich. Westinghouse Service Department.



Using a File on Bearings

In the Oct. 17 issue H. D. Fisher gives one theory of the cause of a bearing heating, due to the shaft being too smooth. It has been a common practice for some years to draw-file high-speed journals that show a tendency to heat. If any piece of metal is examined under a microscope, it does not matter how smooth it is, it will be found that the surface is made up of rough, tooth-like particles. It is the interlocking action of these particles that causes the friction in a bearing.

The irregularities of the surface of the shaft act the same as the blades of a rotary pump; this is the case at all speeds, but more marked at high speed. Not at any time, except when closing down and starting up, is there any metallic contact between the turbine shaft and the bearing. The shaft pumps or carries the oil in the direction of rotation, thereby forming a wedge of oil between the shaft and the bearing. Obviously, the smoother the shaft the less tendency to carry the oil. So when turbine men have trouble with bearings that heat, the first thing they do is to check up the running clearance in the bearing (0.002 in. per inch of journal diameter) to allow the wedge to form, and the second is to see that the shaft is rough enough to pump the oil to maintain the film. A turbine bearing will not last thirty seconds under a metal-to-metal contact, and this is why auxiliary pumps are provided to keep the bearing supplied with oil while closing down or starting up, at which times the oil supplied by the direct-connected pump is not sufficient.

L. LONG.

Chattanooga, Tenn.

Examination Questions

It would appear from the letter by Mr. Summers in the Oct. 3 issue that he considers the examination questions on joints and braces unnecessary. I cannot agree with him on this point, for during my experience as an engineer I have been asked a great many questions on riveted joints, stays, etc., and I have yet to be asked a question that is not practical, or one that any engineer operating a steam plant would consider unnecessary.

As an instance of where the knowledge of the strength of boiler joints can be applied I refer to a case where four new boilers built for 100 lb. pressure were added to a plant in which there were two old boilers operating at 85 lb. pressure. In order to operate the boilers together the engineer was ordered by the management to screw down the safety valves on the old boilers and raise the pressure to 100 lb. This he refused to do, as from his knowledge of joints he knew it would be above the safe working pressure. So an inspector was called in and the boiler was thoroughly examined with the result that he ordered the pressure reduced to 70 lb. This is only one instance where an engineer's knowledge of joints proved of value. Had he not been familiar with the strength of joints, he doubtless would have raised the pressure on these old lap-seam boilers, thereby making them a menace to life and property. This is why examiners ask the questions they do concerning the design and construction of steam boilers.

I fully agree with Mr. Summers that engineers should be examined on the engines and equipment as well as the boilers for safe operation. But as a matter of economy, that is up to the employer and not the examiner. I firmly believe the examiners as a rule try to be fair in their examinations and must be convinced as to the applicant's fitness to be intrusted with the powers and duties of an engineer, which, as a rule, he can determine only by asking questions. Put yourself in his place and examine a stranger for a license and see how hard it is to convince yourself that he knows the business.

R. A. CULTRA.

Cambridge, Mass.

Auxiliary Turbines for High Temperature Steam

In the next to the last paragraph of the editorial in the Nov. 7 issue, on "Auxiliary Turbines for High-Temperature Steam," it is stated that more surface must be used in a closed feed-water heater receiving superheated steam than in one receiving saturated steam. While this idea is widely current, it seems on examination to be somewhat erroneous.

Let us assume an air-free heater in which superheated steam is actually in contact with the metal of the tubes. For a given water temperature the temperature gradient through the metal of the tube would then be greater than if the steam in contact were saturated at the same pressure. The heat transfer through the metal of the tube should therefore be greater. Now, as a matter of fact the steam in contact with the tube, or part of it at least, is saturated, since it is undergoing condensation. The temperature gradient through the metal in the tube should then be at least equal to that obtained with saturated steam. When the saturated steam in contact with the tube surface condenses, it can be replaced only by more saturated steam or by superheated steam; in other words, the metal surface of the tube would at all times be at least as hot as it would be in a heater receiving saturated steam only, and the total heat transfer would therefore be as great.

The foregoing arguments do not in any wise deny

that the coefficient of heat transfer by conduction through superheated steam may be much lower than through saturated steam.

It is difficult to conceive that the inside surface of a steam pipe or the steam-side surface of a heater tube in actual contact with steam is at a lower temperature than the steam. If a layer of water is present, the same arguments apply to the water surface in contact with the steam. If a layer or film of air is present, the matter of radiation from the interior of the body of steam through the air film to the metallic wall may enter, and if anybody has actual data from tests carried out with proper scientific precautions, it would be interesting to have them published.

New York City. C. H. GIBSON.

What Caused the Black Spots on the Commutator?

In the Oct. 31 issue Mr. Macrae asked what caused the black spots on the commutator. He does not state where the spots are located, with reference to the tap coils, or how many collector rings the generators have, or whether the sparking is continuous or occurs in rapid succession, but from what he says, I would suggest that he examine the balance-coil of No. 3 generator. There is a possibility that the tap for the neutral connection is not in the middle of the balance coil. If this is the case, current will circulate between the generators. The path of this current will be through the balance coil and d.-c. brushes of one machine, over the equalizers, through the other machine and its balance coil, and back over the neutral bus. This current will be maximum at those instances when the tap-coil commutator bars of both generators are under the brushes.

The balance coil may be checked by running No. 3 at no load with normal voltage and (using an a.-c. voltmeter of about 125-volt range) measuring the voltage between the neutral tap and each collector-ring brush. For this test No. 3 should be disconnected from the line, neutral and equalizer buses.

If the balance coil is at fault, the commutator trouble may be eliminated (while waiting for a new balance coil) by leaving the neutral bus disconnected from generators Nos. 1 and 2 when these generators are paralleled with No. 3; provided that No. 3 can carry the unbalanced load. C. F. ROYCE.

Wilkinsburg, Pa.

It is my opinion that the trouble is caused by the difference in speed of the Nos. 1 and 3 units. As each engine approaches the dead center it will tend to lag, while immediately after passing the center it will tend to speed up. At certain intervals Nos. 1 and 3 would take steam at the same instant and there would be no interchange of current; at other times they would be directly in opposition and the cross-currents would reach the maximum.

The fact that the burning occurs on the Nos. 1 and 2 units, leads me to believe that the trouble is in these rather than in the larger slow-speed unit. It is possible that they have not sufficient flywheel effect to keep up the momentum while passing over the center, or they may be more heavily loaded, which causes them to surge slightly.

Changing the speed either way on either No. 3 or Nos. 1 and 2 engines and compensating for this with the field rheostats, would be my suggestion, as this might break up the regularity with which the units work in opposition or in unison, and any burning that might occur would be distributed over the entire area of the commutator rather than concentrated at one place.

I have seen this tried out with good results where gas- and steam-engine-driven units were operated in parallel. M. A. ANDERSON.

Pittsburgh, Pa.

As machines Nos. 1 and 2 operate satisfactorily separately or in parallel, and get black spots on their commutators only when paralleled with No. 3, the trouble is probably with the latter machine.

According to the article the machines are paralleled only during heavy load periods, and I think that machines 1 and 2 may have a "drooping characteristic" as the load comes on, and probably No. 3 machine, a trifle overcompounded, has a "rising characteristic" under the same conditions of load; and if this is the case, machine No. 3 would "pump back" current into either No. 1 or No. 2, or both. This, in my opinion would cause the burned appearance of the commutator bars.

The remedy, of course, would be to readjust the shunt in connection with the series field. It would be wise, before making an adjustment, however, to secure the characteristic curves for these generators from the manufacturer if possible. HENRY B. DOWNE.

New York City.

Welding Tubes into the Tube Sheets of Boilers

The questions asked by Mr. Johnson in the Oct. 24 issue in regard to the welding of tubes in the tube sheets of boilers, as described in an article in the Oct. 10 issue, are timely and worthy of consideration, particularly from the viewpoint of strength and purpose of the weld and the safety of operation.

As the tube sheets of all fire-tube boilers are flat, they must be supported, and in my opinion this support should come upon the beading of the tube and welding should be done only to prevent leakage. In reply to the questions asked by Mr. Johnson, I submit the following answers:

Question No. 1: What is the object of welding the tubes into the sheet?

Answer: When boilers have been in operation for some time and tube leakage develops, caused by oil, etc., and after the tubes have been rolled to such an extent that any further rolling would seriously impair their strength, it then becomes necessary either to renew the tubes or weld them to the sheet, and as the renewal of all the tubes may not always justify the expense, it is obvious that welding should be given a trial.

I have operated a battery of vertical fire-tube boilers containing over 5,000 tubes that were welded to the sheet, and after six or seven years' service only two tubes were renewed and the boilers have always passed inspection by the insurance company.

It must be understood, however, that only one end of the tube is welded to the sheet (usually nearest the fire).

Question No. 2: How are they welded in without setting up stresses in the sheet?

Answer: With a good welding outfit, capable of

maintaining the necessary voltage and resistance for the heat and arc desired, and in the hands of an experienced welder, there will be no undue stresses of the sheet. The tubes should first be rolled and beaded if necessary, and a good practice is to carry some water in the boiler while welding, as it tends to keep the sheet cool for continuous work, and care must be taken not to have any leaks around the weld, as water tends to cause the arc to sputter and break.

Question No. 3: How would you determine whether you had stressed the sheet or not?

Answer: By careful examination. Use a magnifying glass if necessary.

Question No. 4: When it becomes necessary to replace a welded tube, how do you go about it?

Answer: With the aid of a pneumatic hammer and chisel, the weld can easily be cut away, leaving the sheet in such a condition that one would hardly know it had been welded; then remove the tube in the usual manner.

Question No. 5: How many tubes could be replaced in the same tube hole without a weakening of the sheet?

Answer: The continued replacing and welding of a great number of tubes would no doubt weaken the sheet, but would not prevent the replacing of a reasonable number. However, a tube that has been replaced does not generally require welding until rolled thin.

New Bedford, Mass. R. G. SPOONER.

Burning a Mixture of Coal and Oil Under the Boiler

In the Sept. 5 issue of *Power*, on page 395, reference is made to the suggestion of the United States Bureau of Mines to burn a mixture of fuel oil with fine coal in the boilers during the present coal shortage. The idea is, of course, not new, and has been worked on for quite a number of years, although in a different form, more frequently as a combined system of burning coal and oil, the latter introduced into the furnace through an atomizer in the ordinary way.

It is only natural that it should recur in the time of a fuel crisis. The writer faced the same problem as far back as 1907 in Moscow. The boilers in most factories were *oil* and *not coal* burners. In 1907 an oil crisis arose; oil became scarce and expensive, deliveries uncertain, factory owners began to think about arranging their boilers for coal burning and many actually did so. It was then that I adopted the system of combining the liquid and solid fuels with the idea of decreasing the quantity of oil consumption and to take advantage of the better coal possibilities.

The results were gratifying with regard to both economy and efficiency of the boiler as compared with ordinary coal burning. This is because in such a combination the efficiency of combustion for the coal part of the charge becomes better, and for the oil the heat is better utilized, the atomizer so mixing the gases from the grate with the air admitted through and above it that combusion is much improved and the excess of air is used by the oil.

By changing the ratio of oil to coal, different results will be obtained, as is only natural. Experiments have shown, for instance, that when one pound of oil is introduced to every five pounds of coal, it will extract, so to say, about 18 per cent more heat units from the coal, in addition, of course, to giving up its own heat value, for which it would not be necessary to introduce any extra air, the excess of air supplied with the coal being sufficient for the added pound of oil.

If we call a the calorific value of the coal when burned alone—that is, without oil—b the calorific value of oil, A the increased calorific effect of the coal when one pound of oil is added to each m pounds of coal, then $m(A - a)$ is the gain in the coal from the introduction of the pound of oil, and the fraction $\frac{b + m(A - a)}{a}$ can be taken as the measure of the increased efficiency of the coal, or the oil, especially if compared with the ratio $\frac{b}{a}$, representing the relative calorific values of a pound of oil and coal; or since for a given kind of oil and coal $\frac{b}{a}$ is constant, the fraction $\frac{m(A - a)}{a}$ can be taken as the measure of such increased efficiency and gain.

A determining factor in the proportion of the oil and coal to be used is the limit of perfect use of air or of the excess of air to be admitted. Apart from this the current prices of coal and oil have to be considered; therefore, it is only by actual experiments upon the given system of boilers that the best results can be determined. R. POLIAKOFF.

New York City.

Some Important Factors Neglected in Boiler Construction

Referring to Mr. Weightman's article in the Nov. 7 issue, I feel that he does not go far enough in making important points in connection with proper baffling of water-tube boilers. It usually pays well to get in touch with people who have qualified as experts on proper baffling because great increases in boiler efficiency as well as boiler capacity are in many cases possible. I would add the following points as important:

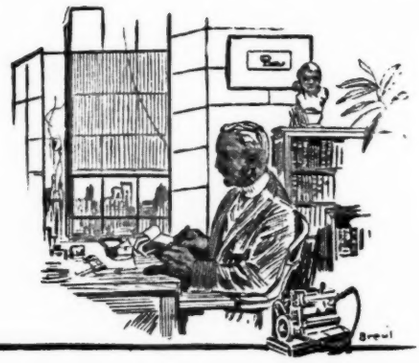
1. Proper placing of baffles.
2. Proper sloping of same to obtain as nearly as possible a uniform velocity of flow of the gases through the entire boiler.
3. Selection of baffles that are molded tightly around the tubes so that short-circuiting is done away with, but so that it is possible to remove and replace tubes without damage to the baffles.
4. Selection of baffle materials which have the greatest possible mechanical strength for the conditions encountered: (a) the material should be able to withstand high temperature and impingement of hot gases and flames. (b) Selection of material that will harden and obtain its true, full working strength even though water-cooled by the boiler tubes.

Contractors installing various types of fuel-burning equipment do not always give proper consideration to baffles. Cases are on record where their work has been considered a failure until baffle experts were called in to install proper baffles, and then this in turn made the jobs successful. G. W. BLAKELEY, Consulting Engineer,

Boston, Mass. Johns-Manville, Inc.

In the description of the power station of the Pittsburgh Plate Glass Co., at Kokomo, Ind., which appeared in the Oct. 31, 1922, issue of *Power*, it was stated that the list of principal equipment included a radiant-type Foster superheater in each boiler setting. This was an error, as the superheaters are of the usual convection type, mounted above the boiler tubes, as shown in the cross-section of the power house.

QUESTIONS AND ANSWERS



How To Find the Wattless Current in an Alternating-Current Circuit

When the voltmeter, ammeter and power-factor meter readings are known, how is the wattless current of an alternating-current circuit determined? P. E. M.

To determine the wattless current in the circuit, it is not necessary to know the voltmeter reading when the power factor is given. The ammeter reading may be considered as the resultant current of two components at right angles to each other; one the power component and the other the wattless or circulating component. As an example say that the ammeter indicates 150 amperes on a circuit where the power factor is 0.75. The power factor of an alternating-current circuit is the cosine of the angle of phase displacement between the current and voltage. By referring to a table of sines and cosines, such as given on page 200, Aug. 8 issue of *Power*, it will be found that 0.75 is the cosine of an angle of about 41 deg. and the sine of this angle is 0.656, the latter being frequently referred to as the reactive factor. The power component I_p of the current is equal to the ammeter reading times the power factor, or in this problem $I_p = 150 \times 0.75 = 112.5$ amperes. To find the wattless component I_w, multiply the ammeter reading by the reactive factor, or $I_w = 150 \times 0.656 = 98.4$ amperes. Since these two currents are out of step by 90 deg., their resultant I, the ammeter reading, is equal to the square root of the sum of the squares of the two currents or $I = \sqrt{I_p^2 + I_w^2} = \sqrt{112.5^2 + 98.4^2} = 150$ amperes, which checks with the assumed ammeter reading.

Emergency Governor Trips When Overload Opens the Main Switch

A 500-kw. turbine unit has recently been causing trouble by tripping the emergency valve and shutting down when an overload sufficient to open the main generator switch occurs. What would you suggest as to the cause of this behavior? R. G. L.

You do not mention checking the emergency governor, and it is probable that this trips at too low a speed. These governors usually are required to trip out at 8 to 10 per cent above normal speed, and should ordinarily be tested once per month, and the hand trip operated on starting up and shutting down. Failure of the main valve to close tightly may cause overspeed to trip the emergency valve, when the load is removed.

With the turbine running at no load, give the throttle just enough opening to allow slow overspeeding, if the main valve fails to close properly. Hold a tachometer on the shaft, unless such an instrument is already installed on the machine, and see if the turbine will overspeed. Increasing speed above normal would be due to leaky main valve or governor travel adjustment being insufficient to allow the main valve to close. If this test is satisfactory, then cause the machine to increase its speed until the normal emergency tripping speed is reached.

The usual method of producing overspeed is to pull against the closing pressure of the governor by hand or with a bar, so as to cause the main valve to be partly open. Some valve gears are equipped with main valves that may be opened by means of a block or bar; it is sometimes more convenient to change the travel adjustment slightly, preventing the main valve from closing, while making the test.

It is probable that the emergency governor will trip much below the proper speed and will require its spring to be tightened until the desired tripping point is reached. Too much dashpot friction will sometimes prevent the governor acting quickly enough when the generator switch opens. Be sure that the valve gear is not sluggish in action.

Do not attempt any adjustments without full instruction or information on these points from the manufacturer.

Arithmetical vs. Weighted Average

What is "weighted average" as compared with arithmetical average for such items as vacuum, temperatures, Co_2, etc.? A. B.

An arithmetical average would be the sum of readings divided by the number of readings. Such an average is useful for interpretation of final results, only when the importance of any reading is directly in proportion to its arithmetical value.

A "weighted average" of a series of readings is the conclusion from taking an arithmetical average of relative weights or importance of the individual readings, and then assigning the nearest reading whose weight would correspond with the average weight so obtained.

For instance, if in a given power plant when, operating with average steam pressure and average load, the hourly vacuum gage readings in inches during an eight-hour run are 28, 27, 26, 25, 27, 26, 25, 25 or the arithmetical average $(28 + 27 + 26 + 25 + 27 + 26 + 25 + 25) \div 8 = 26.12$ in.

It could not be inferred therefrom that the efficiency of the condenser had been the same as though 26.12 in. vacuum had been maintained during the whole run. For suppose it is assumed or known that for 25 in. vacuum the steam economy of the plant would be 19 lb. per hp.-hour; for 26 in., 18 lb.; for 27 in., 17.75 lb.; for 28 in., 17.5 lb. Then the relative weights would be $\frac{1}{19}$ for 25 in.; $\frac{1}{18}$ for 26 in.; $\frac{1}{17.75}$ for 27 in.; and $\frac{1}{17.5}$

for 28 in.; or assuming for 25 in. vacuum a weight of 1, the relative weights would be

$$\text{For 25 in. vacuum } \frac{1}{19} \div \frac{1}{19} = 1$$

$$\text{For 26 in. vacuum } \frac{1}{18} \div \frac{1}{19} = 1.055$$

$$\text{For 27 in. vacuum } \frac{1}{17.75} \div \frac{1}{19} = 1.074$$

$$\text{For 28 in. vacuum } \frac{1}{17.5} \div \frac{1}{19} = 1.086$$

Then for the hourly readings of 28, 27, 26, 25, 27, 26, 25 and 25 the average would be

$$(1.086 + 1.074 + 1.055 + 1 + 1.074 + 1.055 + 1 + 1) \div 8 = 1.043,$$

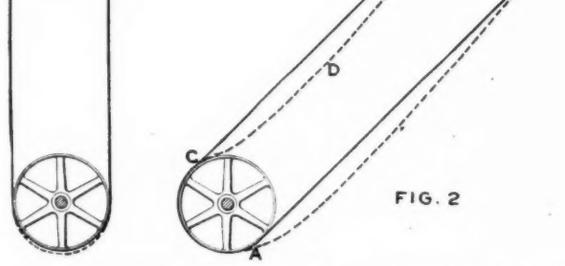
As for 1 in. vacuum above 25 in. the increase of weight is 1.055 — 1 = 0.055 in., then by interpolation the average weight of 1.043, or 0.043 in excess of 1, which is the weight of 25 in., would be 0.043 ÷ 0.055 = 0.78 in., and the "weighted average" would be 25 + 0.78 = 25.78 in. vacuum. By taking the weighted average it is found, as above, that the economy should be the same as though 25.78 in. vacuum, and not the arithmetical average 26.12 in., had been maintained continuously.

Advantages of Inclined Belt

Why is an inclined belt better for power transmission than when the belt is vertical? G. C. L.

When a belt is placed over a pair of pulleys at rest, both sides of the belt may be assumed to have the same tension, but as soon as transmission of power takes place, the driving side stretches, resulting in less tension in the slack side.

If the sides of the belt are vertical, as in Fig. 1, the greater length delivered to the slack side, combined with the weight of the belt, reduces the tension and may be sufficient to permit the belt to fall away from the face



RELATIVE CONTACT OF VERTICAL AND INCLINED BELTS

of the lower pulley, as indicated by the dotted line, Fig. 1.

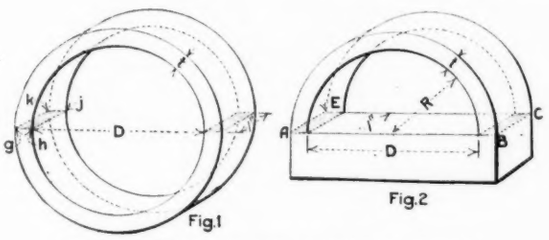
When the belt is inclined, as shown in Fig. 2, an increase of tension on the driving side reduces the tension in the slack side, but from the weight of the belt there is less reduction of the arc of contact with the lower pulley than in the case of a vertical belt.

If the lower side *AB* is the driving or tight side, the slack side, as indicated by the dotted line *CDE*, becomes wrapped around more of the lower pulley. If the upper side *CE* is the tight side, the slack side assumes the dotted position *AB*, and nearly as much of the belt continues to be wrapped around the lower pulley. Hence, with the same initial tension, when a belt is inclined it retains better contact with the lower pulley and therefore is capable of transmitting more power than when the sides are vertical.

Hoop Stress in Cylindrical Shell

What is meant by the hoop tension of the material of a boiler shell, and knowing the diameter and pressure, how are the hoop tension and tensile stress per square inch computed? R. N. C.

The term "hoop tension" applies to the circumferential stress to which the material of a cylindrical pressure vessel is subjected in offering resistance to inter-



HOOP STRESS IN CYLINDRICAL SHELL

nal pressure, in the same manner as when resistance to internal pressure is offered by the tensile strength of a hoop around a barrel.

Referring to Fig. 1, suppose a cylindrical shell 1 in. long, of diameter D inches and thickness t inches is subjected to internal pressure of P pounds per square inch. Then, neglecting any assistance that may be rendered by the heads, or covering of the ends of the shell, the upper half would be held to the lower half by the tensile strength of two diametrically opposite sectional areas like *ghjk*. The total pressure resisted by the two sections would be the same as though the upper half were joined to a solid with a plane face *ABCD*, Fig. 2. In the latter case the total pressure to be resisted evidently would be the area $D \times 1 \times P$, or DP, and therefore the tensile stress of each side, or in fact the hoop tension across a longitudinal joint, or in any part of the cylindrical shell 1 in. long, would be $(D \times P) \div 2$ or $R \times P$.

As the cross-sectional area in square inches of a radial section like *ghjk* is $t \times 1$ or simply t, it follows that the hoop stress per square inch of cross-section of the solid part of a shell of radius R inch and internal pressure P pounds per square inch, would be $(R \times P) \div t$.

Apparent and Real Cutoff

What is the difference between apparent and actual cutoff?—M. L. W.

The fraction of stroke at which the admission of steam to the cylinder is cut off is the apparent cutoff. The real cutoff is the ratio of the actual volume of steam in the cylinder and clearance space when the piston is at the point of cutoff, to the volume of steam in the cylinder and clearance space when the piston has completed the stroke. For instance if the cutoff occurs when the piston has completed one-fourth stroke, the apparent cut is 0.25; and if the clearance volume is 5 per cent of the piston displacement per stroke, then the real cutoff would be (0.25 + 0.05) ÷ (1 + 0.05) = 0.285.

The Hepburn-Forbes Internal-Combustion Turbine System*

By W. A. D. Forbes

AS A RESULT of some years of study of the problems involved, the writer of this article and his colleague, H. A. Hepburn, B.Sc., A.M.I. Mech. E., have proposed a new system of operation, a description of which it is hoped may be of interest, as it is based upon a new theory of nozzle action and involves the use of a novel type of pump, known as a "kinetic compressor."

In the Hepburn-Forbes gas-turbine system the sub-atmospheric, single-fluid, constant-pressure cycle has been adopted, as it is considered that it yields the most promising line of development.

Use of Kinetic Compressor

Attention has been directed toward the employment of greater compression ratios than are possible with a rotary compressor, and the utilization of the kinetic energy remaining the gases after leaving the moving turbine blades. To attain these ends, it is proposed to use a kinetic compressor in which the kinetic energy of the gases is converted into pressure energy. How this is to be done will be described later. It can readily be seen from theoretical considerations that an increase in the mechanical efficiency of the expansion part of the cycle will lead to a substantial improvement in the over-all efficiency, and that this is particularly the case for the constant-pressure type of turbine. By allowing the gases to leave the turbines with sufficient velocity to enable the whole of the compression work to be carried out in a kinetic compressor, it is found that there is an improvement in the over-all efficiency which may amount to the order of 80 per cent or more above that obtained when a rotary compressor is employed.

Having given up the rotary compressor, it becomes necessary to produce and maintain the vacuum by other means. It is proposed to maintain the vacuum by the expansion of high-pressure gas in a nozzle system. When gas expands through a nozzle, there is a tendency in certain circumstances to go on expanding beyond the back pressure. What vacuum pressure can be produced by the expansion of gas through a nozzle from a pressure greater than that of the atmosphere? The theory advanced by Mr. Hepburn and

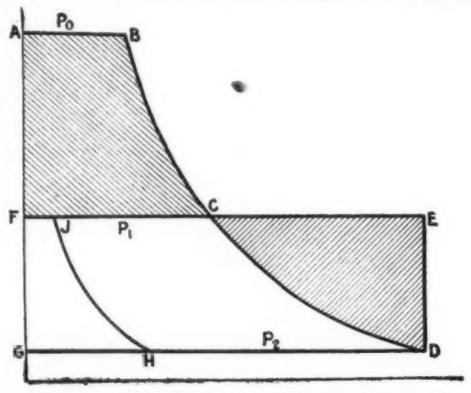


FIG. 1—ACTION OF NOZZLE EXPANSION

the writer is that under favorable circumstances the expansion will continue until the atmospheric line becomes the m.e.p. line of the P. V. diagram. That is, if p_0 in Fig. 1 is the initial pressure and p_1 the atmospheric pressure, then the expansion would continue until a pressure p_2 was reached, such that the shaded area *ABCF* was equal to the shaded area *CED*.

So far as the writer is aware, this particular relationship has not hitherto been published by others. Experimental evidence confirming this theory can be obtained from the nozzle experiments of Stodola. On page 64 of his book on "Steam Turbines" (second English edition) Stodola gives a series of curves obtained with a diverging nozzle, using steam, in which the back pressure was given various values greater than that for which the nozzle was designed. After passing the minimum section, the pressure fell along the line of adiabatic expansion until a point was reached considerably below the value of the back pressure and afterward rose until the back pressure was reached. Assuming

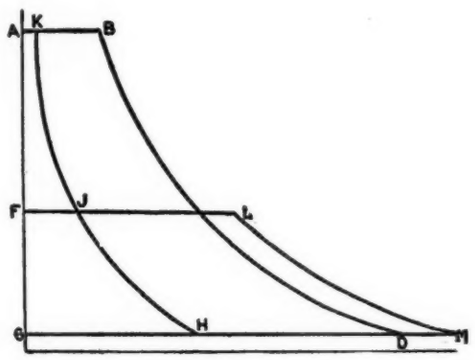


FIG. 2—SUGGESTED GAS-TURBINE CYCLE

the foregoing theory to be true, it will be found that the value of the minimum pressure so calculated is in each case in fair agreement with the experimental result. The theory here advanced explains many interesting points concerning nozzles and orifices and the trains of waves that sometimes arise, and also points in the action of ejectors, to the reason why a considerable drop in the initial pressure gives only a slight decrease of vacuum. It would take up too much space, however, to enter more fully into this matter, but it is suggested that it would form a starting point for formulating a theory of the action of an ejector.

Induction of Main Charge

When the vacuum has been established, a further supply of air, in which fuel has been burned at atmospheric pressure, can be induced to expand down to the vacuum pressure and do work in the turbine. The gas that expands from the pressure p_0 is termed the "operating gas," and the gas that it induces to flow from the atmospheric pressure p_1 down to the vacuum pressure p_2 is termed the "induced gas." The gases, after doing work in the turbine, are cooled at constant pressure to the point *H*, Fig. 1, and are then compressed in the kinetic compressor back to atmospheric pressure. The amount of induced gas that enters the system per pound of operating gas depends on the ratio of the areas *ABDG* and *FJHG*.

The sequence of operations is as follows: Operating air is compressed in a mechanical compressor from *J* to *K*, Fig. 2. Oil is burned in a high-pressure combustion chamber from *K* to *B*. Expansion takes place from *B* to *D*, producing a vacuum in a region surrounding the operating gas nozzle, and the vacuum is transferred to the outlet end of the cooler. The induced gas in which oil has been burned at atmospheric pressure from *J* to *L* is caused to expand from *L* to *M*. The weight of gas that can be thus induced to flow down to the vacuum pressure and pass through the turbine is about four or five times that of the operating gas.

As the operating gas expands from a higher pressure, it has a greater velocity than the induced gas on entry to the turbine. For this reason the operating gas alone is passed through the first row of moving blades. The operat-

*Extracted from *The Engineer*, London.

ing and induced gases are both passed through the second row of blades, and on exit they mingle without shock, as they have approximately equal velocities. The temperature of the operating gas after expansion may be much lower than that of the induced gas, and the operating gas may therefore be used to give a lower mean temperature to the second row of blades.

On exit from the turbine the mingled operating and induced gases pass through the cooler to the kinetic compressor. The cooler consists of a steam boiler in which the water and steam flow in a direction opposite to that of the exhaust gases. The cooler is so arranged as to permit of the exhaust gases flowing through with a minimum reduction of their velocity. Owing to the big relative velocity between the water and steam and the exhaust gases, the rate of transfer of heat should be very rapid and much greater than that obtained in a water-tube boiler. The power obtained from the cooler is used to operate auxiliaries, and part may be used for working a refrigerator for obtaining a supply of cold brine for surrounding the extreme end of the cooler and the kinetic compressor.

The kinetic compressor consists of a number of approximately circular chambers, each having a tangential inlet and outlet. In the body of each chamber there is a spinning mass of gas, which is kept in rotation by absorbing a part of the energy of the gas passing through the chamber. The kinetic energy of the entering gas is converted into pressure energy by the joint action of the centrifugal force caused by the constrained motion in a curved path, and the centrifugal force exerted by the spinning mass of gas. The pressure at the center of the spinning gas is equated to that of the gas entering the chamber. If necessary, to assist in maintaining the spin of the core of the gas, blades operated by an external power source may be fitted where the velocity conditions permit.

Practical Considerations

Whether it is possible to maintain such a spinning mass of gas is a matter for experiment. If it is feasible, the writer feels confident that a solution of the gas-turbine problem has been achieved. In a paper on "Flow of Air Through Nozzles," by Morley, which was read before the Institution of Mechanical Engineers in 1916, it was shown that when a jet is discharged into a room, the air in the room flows into the jet and vortices are set up, which, once set going, continue without abstracting any appreciable quantity of energy from the jet. In the suggested kinetic compressor the kinetic energy of the spinning gas is a very small fraction of that of the gas that passes through the compressor.

If successful in action, a pump of this type has great advantages over a rotary compressor. There is, for instance, no leakage loss and no bearing friction loss, and it would be possible to utilize much greater compression ratios. The bulk of the pump will be greatly reduced on account of the much higher peripheral velocities employed, and it will be possible to obtain in three stages the same compression ratio that would require more than ten stages in a rotary compressor. Moreover, the simplicity of the compressor makes it exceedingly attractive. In the kinetic compressor the gas would be in a constant state of deceleration, whereas in a rotary compressor the gas is accelerated and decelerated many times in the course of compression, with consequent loss in eddies and shocks.

The natural objection that occurs to anyone who has not given much consideration to the matter, is that the high velocities used will lead to big frictional losses, but a closer investigation shows that, contrary to what would be expected at first sight, these losses are not excessive. This is chiefly due to working on a sub-atmospheric cycle, which gives a low average density, and also the high velocities lead to small surface areas and a small number of stages in the compressor. The high gas speeds used should facilitate the rapid transmission of heat to the cooling medium.

One of the principal advantages of the system is that, apart from auxiliaries, the only moving parts are the turbine wheels and the gas, a simplicity it would be difficult to rival.

Operating on the Hepburn-Forbes system, the calculations, in which reasonable allowances have been made for losses, show that an over-all efficiency approximating to that of the Diesel engine should be obtained, and there is therefore a wide margin for unforeseen contingencies between this value and the efficiency of the very best steam turbine.

The Need of Educated Engineers in the Refrigeration Field*

By Dr. F. P. Siebel

It is difficult to say much that is new on education which, because of its immediate and intimate relation to the advancement of civilization, has been given more thought than perhaps any other subject. This is rightfully so, because without knowledge progress, of which it is the very foundation, would be impossible.

Defining education as applied to refrigeration engineering, we may say that it is the knowledge of applying science systematically to the economic production of ice and refrigeration. In former years this knowledge was at least partly gained by hard knocks through many years of wearisome toil in the "school of experience," which, at the best, has in the majority of instances proved itself to be neither definite nor thorough.

The old adage, "Knowledge is power," cannot be repeated too often, since the achievement of success in the industrial world is invariable in direct proportion to the mental attainment and ability of the individual. While it cannot be gainsaid that practical experience is an essential prerequisite of a thorough understanding of engineering, observation has proved with equal certainty that a thorough knowledge of the fundamental scientific principles involved will insure not only a more rapid, but also a more thorough acquisition of the practical training, by knowing the whys and wherefores at each successive stage in practical manipulations.

Economic conditions of today demand organization, the scientific use of raw materials, routing, inspection, scheduling and other productive factors, the execution of which to the necessary degree of perfection is made possible only under the guidance of one who possesses not alone the practical experience, but also a technical training.

Recognition of the need of technical guidance by those plant owners and organizations that are sincerely desirous of success, will awaken, as is true with the leaders in other industries, to the fact that practical experience alone is no longer sufficient to serve the industry's needs. This period is no longer coming; it is here now, and only such chief engineers as have kept pace with the trend of the times and who are prepared when called upon to meet this condition, are going to win out and be successful.

Unfortunately, too many are inclined to minimize or entirely disregard this industrial evolution until they find themselves suddenly replaced by a more progressive brother or else they feel that they are underpaid, losing sight of the fact that every untrained employee pays for the supervision which he requires on the part of his superior because the employee lacks knowledge of the essential technical points of the industry. So it is that we are again squarely confronted by the question of the "survival of the fittest."

The greater knowledge and efficiency demanded by the refrigeration industry today can no longer be gained through the school of experience nor through scattered haphazard reading nor through misguided and necessarily restricted personal investigations. As a matter of fact a superficial knowledge, such as, unfortunately, numerous engineers are satisfied with, may prove harmful in the end.

To provide this needed technical instruction, institutions of learning were created which are properly designated as technical colleges or highly specialized industrial schools. These schools differ from the academic in so far that at the university practically as much time is devoted in the course to subjects of culture as to the special subjects of

*Extract of paper read before the annual convention of the National Association of Practical Refrigerating Engineers, Nov. 2, St. Louis, Mo.

the respective course. The whole aim and purpose of the technical college or industrial school, is to keep the student constantly moving in a definite direction, and being satisfied with the culture that is a natural sequence of a better education.

There is no refrigerating engineer who can afford to be without this engineering training. A better knowledge of the finer points of the technic of the industry is necessary to the engineer who is really desirous of being efficient, and as all know only the efficient man has all the chances of success in his favor.

How the Navy Is Economizing

By emphasizing the necessity of keeping boiler tubes clean, by substituting gradually the use of a coarser oil as fuel (a transition that is in the experimental stage), by a close watch to detect and stop all steam leaks and by experiments with individual blowers to obviate the necessity of having the entire fireroom under pressure when in port, the Navy Department has effected many economies in operating the fleet, and officials are hopeful of making further strides in this direction.

The repair and the design divisions of the Bureau of Engineering have made progress both in reducing operating costs and in increasing efficiency. Close watch is being kept to see that boiler tubes are kept clean. It has been found that in ships that had been laid up five or six months, soot, dampened by moisture coming down the stacks, has formed a hard substance so heavy that in certain cases some of the one-inch tubes had to be cut out. In some types of boilers it was necessary to cut extra doors in the casings in order to get at the accumulation, and in a few destroyers as much as forty bucketfuls of soot was removed. Ordinary blowing with steam does not remove all the soot.

Experiments are being conducted with "bunker C" oil as fuel, which is two grades heavier than "bunker A," formerly used by the Navy. Most of the battleships and some destroyers now are consuming "bunker C" with results promising equal efficiency.

Forced draft has always been expensive to operate while in port, owing to the necessity of having the entire fireroom under pressure in order to keep up headway steam. The Bureau of Engineering is developing a small, individual blower for each atomizer, which, if successful, will not only reduce expense, but will remove some of the fireroom noise and certain hazards of operation. The experiments have progressed to the point that the individual blowers have been ordered installed on some of the destroyers. This is a comparatively inexpensive change.

New Book on Fuels Is a Mine of Information

American Fuels—(Two volumes, part of the Mellon Institute's Technochemical Series.) By Raymond Foss Bacon, Ph.D., Sc.D., Consulting Chemical Engineer, formerly Director of the Mellon Institute of Industrial Research, and William Allen Hamor, M. A., Assistant Director of the Mellon Institute—with the collaboration of specialists. Published by McGraw-Hill Book Co., Inc., New York, 1922. Cloth; 6 x 9 in.; 1257 pages; 383 illustrations. Price, $12 for the set of two volumes.

With nearly 1,300 pages of practical and specific information on American fuels and their applications, and with the various divisions of the subject thoroughly covered by twenty-two experts, this book stands out as an achievement that should add to the prestige of the authors and their collaborators, and should be of immense help to all those interested in any kind of fuel for any industrial purpose. It deals with the subject of fuels in the broadest way, not being confined to the power aspects of the problem. Although it is impossible, even in a rather long review, to give more than the barest outline of the contents, the following notes may help the reader to get a general idea of this book.

In the first chapter Marius R. Campbell, of the United States Geological Survey, presents a 43-page discussion of the coals of the United States, giving particular attention to ranks of coal, classification of coal areas, etc. A valuable feature of this chapter is its compilation of nearly 300 analyses of American coals classified by states.

The principles of combustion are explained by Arthur D. Pratt, of the Babcock & Wilcox Co. The presentation of this topic is designed to meet the needs of factory executives and industrial engineers.

The importance of the technology of coke is attested by the 141 pages of solid information prepared by F. W. Sperr, Jr., Chief Chemist of the Koppers Co. Some of the subjects receiving extensive treatment are: Qualities and conditions required for coke manufacturing; theory of coking; physical and chemical study of different varieties; applications of coke; bee-hive ovens; design and operation of all types of byproduct ovens; screening practice; gas and other byproducts; testing; bibliography.

The production and application of briquetted fuels is adequately covered by G. J. Mashek, president of the Mashek Engineering Co., while F. Parkman Coffin, of the General-Electric Research Laboratory, devotes 61 pages to an economic review of coal preparation and utilization. The subject is here discussed from the broadest possible viewpoint, great stress being laid upon the economic advantages that may be expected from utilizing our coal resources on a multiple-product basis.

The same author has contributed three other long and valuable chapters to this book. One is on the gasification of fuels, dealing with every phase of gas-producer engineering, while another takes up the distillation of coal at low temperatures, giving in 120 pages a careful analysis of the research work along this line and the scientific and economic questions involved in present-day practice.

The last chapter by this author deals with finely divided fuel. It is worthy of special note, because it really constitutes a book of 240 pages on the subject, and treats it with the greatest thoroughness. The following are a few of the general subjects taken up: Uses of pulverized coal, mechanical preparation of coal, coal cleaning, the Trent process, conveying pulverized coal, burners, feeders and mixers, firing boilers, study of early and recent installations, central-station possibilities.

In Chapter 9, A. W. Smeltz, of the Westinghouse Electric & Manufacturing Co., devotes 38 pages to the development of mechanical stokers. In this he describes the construction and operation of the well-known types and states the advantages of stokers over hand firing.

After a short article on the use of wood for fuel, contributed by the Forest Service of the United States Department of Agriculture, there is a chapter of 85 pages on fuel oil and its utilization, by B. Stanley Nelson, chief engineer, A. M. Lockett & Co., Ltd. Among other things, this deals with the following: Supply, advantages of oil as a fuel, efficiency, storage and handling, burners and furnaces, application to boilers, underwriters' regulations, bibliography.

Colloidal fuels are discussed by Lindell T. Bates, and natural gas by Samuel S. Wyer, consulting engineer. Next comes a chapter of 81 pages on producr-gas technology, by F. W. Steere of the Steere Engineering Co. After warning the reader of the pitfalls to be found in producer-gas engineering and calling attention to the need of operators specially trained for this work, the author takes up the chemical reactions, classification of producers, etc., and then goes on to discuss the practical problems of operation, and the applications of producer gas. There is an extensive bibliography at the end of the chapter.

Water gas and blast-furnace gas are treated respectively by A. E. Blake of the U. G. I. Contracting Co., and by J. M. Camp and C. B. Francis (Carnegie Steel Co.), while the Dayton process for the manufacture of gas from oil is described by F. C. Binnall, chemical engineer, who is also the author of the chapter on the relative values of gaseous fuels. The chapter on surface combustion, by A. E. Blake, explains the theory and describes the various types of furnaces used.

The future of the artificial-gas industry is discussed by F. C. Weber, gas engineer, Henry L. Doherty & Co., and

heat-treatment applications by D. K. Bullens, president of the D. K. Bullens Co. E. F. Collins, consulting engineer with the General Electric Co., contributes a chapter on the relative thermal economy of electric and fuel-fired furnaces.

Chester G. Gilbert (Arthur D. Little, Inc.) and Joseph E. Pogue, consulting engineer, whose jointly written book on the subject has already attracted wide attention, have a chapter on the economics of American power practice. They treat the subject from the broad, political and economical basis of the national welfare. Closely allied to this is the chapter on fuel conservation, by Horace C. Porter, and that on some problems in the utilization of fuel, by R. F. Bacon and W. A. Hamor. Mr. Hamor is also the author of the chapter on the problems of the petroleum industry, in which he discusses the following topics: Draft on petroleum resources, problems in production and refining, gasoline substitutes, fuel-oil substitutes, research on petroleum products.

The book has two appendices, one entitled "Method for the Analysis of Coal" and the other "Methods for Testing Fuel Oils and Specifications for Fuel Oils."

The foregoing synopsis may seem long, yet it cannot be said to cover more than the high spots of this treatise. It is hard to think of any aspect—chemical, mechanical, economic or political—of the fuel problem that has not been thoroughly and competently covered.

Steinmetz Urges Full Use of Water Power

"If we in New York State would develop all our available water power, by the present established methods, we could shut down every steam engine and steam locomotive and run our industries and railroads on hydro-electric power, using coal for domestic heating only," said Dr. Charles P. Steinmetz, in an address delivered recently before the Advisory Council of the Federated Engineers Development Corporation. "Such water-power development would reduce our coal consumption to about 10,000,000 tons, less than one-fifth or what we use now."

The complete development of water power in New York State should dispel all fears of coal strikes, according to Dr. Steinmetz. With coal production reduced to one-third normal, during a strike, there would still be enough coal for domestic heating. Dr. Steinmetz gave the total power consumption in New York State as about 5,000,000 hp. Of this amount only about 1,300,000 hp. is hydro-electric. The steam power used, exclusive of railroads, is 3,700,000 hp., requiring the consumption of 35,000,000 tons of coal each year, while the railroads of New York State use an additional 12,000,000 giving a consumption for power purposes of 47,000,000 tons, about two-thirds of the total consumption.

Dr. Steinmetz gave the total undeveloped water power in New York State as 4,000,000 hp. and then raised the question of why so much of this power was still undeveloped. In attempting to answer this question, he drew a comparison between New York and California. Both are similar, he said; both are industrial states; both are agricultural to a considerable extent. And yet California uses about twice as much electrical power as New York State. California's power is about nine-tenths hydro-electric and one-tenth steam-generated, while of the electric power in New York, only one-third is from water power and two-thirds from coal. The investment in water-power development in New York State is about $12 per person; in California. $114 per person—about nine times as much. The reason for this difference, according to Dr. Steinmetz, is that California has no coal, while New York State is surrounded by coal-mine territory. Therefore, coal in California has always been expensive, and that state has had to develop its hydro-electric resources from the beginning, whereas in New York the use of coal was natural, since coal in the past has been cheap, and its use has obviated the large initial investment required for developing hydraulic resources. But during the last ten years the cost of coal has trebled. In New York State the cost of coal is now as high as it was in California when the high price of coal there caused hydro-electric development. From this, Dr. Steinmetz concludes that the development of water power is now imperative. "Our experience with coal strikes and railroad strikes this year," he said, "has made it clear that a change must be made, and it will probably be drummed in more forcibly still during the coming winter that it is not safe for the Empire State to rely upon coal. There is a way out—it is to make ourselves independent as far as the coal industry is concerned, by developing our water power."

William Henry Patchell Honored at Dinner

On Friday evening, Nov. 10, some forty engineers of New York and vicinity assembled for a dinner at the Engineers Club, at the invitation of the New York Edison Company, to do honor to William Henry Patchell, vice-president of the Institution of Mechanical Engineers of Great Britain.

John W. Lieb, vice-president of the New York Edison Company, made a happy toastmaster. George A. Orrok, consulting engineer of the same company, explained Mr. Patchell's services to the profession. During his forty years of professional life he has been interested in subjects as widely diversified as electricity supply and agricultural motor tractors, graving docks and colliery equipment, heat transfer, and jigs and special machinery. Add to this nozzle experiments, welding, byproduct coking, insulation, photometry, and arc lamps, and we get a partial cross-section of what has occupied his mind. But, with all, his main interest has been in the generation, distribution and utilization of electrical power.

Starting with his apprenticeship at Robey & Company during the early days of the central station, he has been in close touch with the manufacturing, construction and operation of power plants through their extensive development up to the present time, always keeping a good lead and never afraid of innovation, although his designs have been conservative. The speaker recalled Mr. Patchell's memorable paper upon superheater experiments in 1896 and his leadership in the use of large boilers at Bow Station in 1905. He has been honored with the vice-presidency of the Institution of Electrical Engineers and the Institution of Mechanical Engineers. Those of us who have been strangers in a strange land, even though that land be not alien in tongue, remember his welcome to us, his care that we saw what we came for, that we understood the conditions and the people, his unfailing courtesy, and most particularly the friendliness of our reception.

Remarks were also made by Alexander Dow, president of the Detroit Edison Company, for which company Mr. Patchell is consulting engineer; F. W. Smith, president of the National Electric Light Association and vice-president of the United Electric Light & Power Company; Col. P. Junkersfeld, of Junkersfeld & McClelland; and W. S. Barstow, president of the W. S. Barstow Company.

Mr. Patchell, who is returning to London this month, told most entertainingly of his experiences in becoming acquainted with American engineering and vernacular, gave an interesting account of recent engineering activities abroad and touched upon the registration or licensing of engineers and the formulation of a testing code for steam boilers. A joint committee has been appointed by several of the British societies for this purpose. He has been supplied with proofs of the tentative A.S.M.E. Code and hinted at the possibility of a code that should be of international application and in the making of which the engineers of the world should have a hand.

Preliminary figures on the United States exports of electrical goods for September reflect the improved conditions noticeable throughout the industry. The total exports, valued at $5,238,753, represent an increase of $487,583 over the preceding month. The month's total also compares favorably with that for September, 1921. Important shipments of power transformers and power switchboards were made during September, the total being $499,755 and $365,348, respectively. These exceeded by substantial amounts the heavy export shipments of these classes of electrical material in August.

News in the Field of Power

Irrigation Versus Power

Engineer Argues for Co-ordination in Columbia Basin

HOLDING that irrigation is of greater importance than water-power development in the Columbia River Basin, Marvin Chase, supervisor of hydraulics for the State of Washington, has submitted a minority report which will be included in the Board of Engineers' report on the use of the waters of the upper Columbia River. This board was appointed at the instance of the Federal Power Commission, and its report will be available for distribution before the end of the year.

In his minority report Mr. Chase advocates the construction of the officially adopted Columbia Basin irrigation project. He protests against the granting by the Federal Power Commission of power rights that might conflict with this irrigation development. He also expresses the belief that irrigation and power-development projects could be co-ordinated by developing the waters of the Flathead, Clark Fork, Spokane, and upper Columbia Rivers, which would yield the maximum commercial power, near existing and probable markets, and would make possible the subsequent use of the waters for irrigation.

Opinion of Majority

The majority of the Board of Engineers points out that it is essential that the Commission, in passing upon permits and licenses, follow a well-defined policy for the most efficient use of the resources of a river. They admit, however, that freedom should be given to the fullest irrigation expansion in Montana, Idaho and Washington; that no power rights should be granted interests on the lower waters of a stream which would interfere with irrigation upstream, and that the Columbia Basin irrigation project is the most important single item to be considered in the uses of Columbia River water above the mouth of the Snake River. They recommend that a permit to develop power at any point on the Columbia River as far down stream as the Foster Creek site should not be granted to power interests until it is known that such site will not be needed by the irrigation project.

New Governor of Oklahoma Is an Engineer

In Oklahoma an engineer, J. C. Walton, has been serving as Mayor of Oklahoma City, and now comes word that on Nov. 7 he was elected Governor of the state. Prior to his term as Mayor of Oklahoma City, Mr. Walton practiced mechanical engineering in a consulting capacity, specializing on municipal water works.

A novel feature of Mayor Walton's inauguration as Governor will be an old-fashion, two-day barbecue at which Mr. Walton expects to entertain 50,000 persons from all parts of the state. To accommodate the crowd, Mr. Walton plans to erect tents on the State House grounds. Three hundred head of cattle will go to make up the barbecue feast. The presence of twenty-five orchestras will go far toward making it the most unusual Inaugural Ball ever held.

Is There Any Patriotism Among Coal Men?

THE PURPOSE of the new Federal Coal Commission is to lay bare the whole truth about the coal industry in such a way as to promote a friendlier feeling between the employers and employees who bitterly opposed each other this year in a five-months' strike.

Of course, the inquiry will be valueless unless out of it the real facts can be found and justice may be done—peaceably, if it can; forcibly, if it must. But what an impulse it will be to the lifting higher of the standard of the republic if, out of the inquiry, each of these contending forces shall ultimately discover that there is a patriotic side to every business conducted in America, and that they rise to the highest type of American citizens who so adjust their business grievances in accordance with the principles of organized self-control as to render unnecessary any governmental interference whatsoever!

—From an address by Thomas R. Marshall, former vice-president and a member of the Coal Commission, before the Detroit Banker's Association on Nov. 14.

Navy Cuts Down Waste

Waste in the Navy is being eliminated with a vengeance, according to Admiral Robison, its chief engineer and the head of the Navy Department's Bureau of Engineering. An effort is being put forth to make each seventy-five cents do one dollar's worth of work, because of the drastic reductions made by Congress in the appropriations for the current fiscal year. Efficiency afloat has been increased to the point where engineering costs will be $10,000,000 less than during the last fiscal year, and at the same time an increased average annual mileage per ton of 12 per cent is being shown. While some of this saving is attributable to lower costs and to the fact that there are a few less vessels in service, the greater portion is due to increased efficiency and to the elimination of waste.

Patent Office Still Swamped

Cannot Handle Flood of Applications —Industries Take Best Men

ALTHOUGH Congress enacted last spring a bill increasing Patent Office salaries and authorizing 29 additional examiners and 22 clerks, the work of the office is no more advanced in overtaking the number of pending applications than it was a year ago. This is attributed to a steady increase in applications for patents and for the registration of trade marks.

With the revival of industry the Patent Office also is having difficulty in holding experienced technical men as examiners against the inducements of private employment. While 362 examiners are authorized, approximately a dozen vacancies exist because of the inability of the Civil Service Commission to supply qualified men at the salaries offered.

Resignations Are Many

It was stated at the Commissioner's office that within 49 working days 22 examiners submitted resignations. This is serious as it requires six months for a new employee to become accustomed to an examiner's work. Also, if two resignations come in a single division, two divisions are disturbed as one new man is put in and an experienced examiner is transferred from some other division to fill the second place. In one division the examining staff now consists of two who have been with the Patent Office only three years, two who have been there two years and three who have been there less than a year.

The flood of applications that set in during and after the war has made it difficult to speed up the work as had been hoped for, although in several weeks this year the Patent Office has cleared more patents than it has received applications. Up to Nov. 1, 32,582 first patents had been issued for the calendar year, compared with 37,885 during the entire twelve months of 1921, which shows a higher rate of issuance this year. On Jan. 3, however, there were 60,244 cases up for action in the office, and on October 31 this had increased to 70,313. The greatest activity among applicants has been along chemical and electrical lines.

A distinct forward step in heating and ventilation lies in the use of a centralized desk control system in the new Theodore Roosevelt High School at St. Louis, through which one man may ascertain the temperature and humidity in any section of the building by simply pressing the proper button. If more heat is required, or if the humidity is not what it should be, the desired changes may be readily obtained by manipulating a set of control levers.

Utilities Short on Coal

Disagree with Federal Fuel Distributor As to Outlook

DESPITE reassuring statements from the Department of Commerce and from the federal fuel distributor, representatives of the public utilities contend that the coal situation so far as they are concerned, is getting worse instead of better. They believe that there are duplications in the car-loadings figures published by the American Railroad Association. Hampered by fixed incomes, in bidding for coal against manufacturers, the utilities believe that nothing short of the re-establishment of priority will enable them to build up the reserves necessary to carry them through the winter.

Eastern and Middle Western utilities have been asked to await the closing of the Lakes before attempting to build up storage. They contend, however, that the closing of the Lakes means that freezing weather has arrived and that a tonnage far in excess of that moving up the Lakes will have to be delivered to domestic consumers. Moreover, the advent of cold weather means that the railroads are 20 per cent less efficient. Transportation disability, the public utilities contend, will be even greater this winter because of the run-down condition of motive equipment.

The point on which the public utilities are placing most emphasis in their representations to the fuel distributor and to the President's coal commission is that deliveries on their contracts frequently are as low as 15 per cent, while in only rare instances are they exceeding 50 per cent. The high prices being paid for coal in the Middle West have unbalanced the transportation movement from Eastern mines, and this situation is further curtailing the chances of the public utilities to secure reserves sufficient to insure the proper margin of safety.

Three-Shift Day Favored by American Press

The findings of the F.A.E.S. Committee on Work Periods in Continuous Industry have come in for a good deal of discussion in the American press. World interest in the abandonment of the two-shift system has been stimulated by the Committee's work and foreign newspapers and periodicals carry articles telling of the increasing adoption of the three-shift day, which has been made the subject of a report by the International Labor Office of the League of Nations.

While American papers are almost unanimous in their praise of the report, the Baltimore *News*, perhaps, sums up better than any of the rest its real value, as follows:

It is important to note that the committee was working along scientific and technical lines. It was an economic and not a humanitarian study, and the committee's conviction that the twelve-hour day will soon disappear is the result of economic hard-headedness rather than of an enthusiastic pursuit of a humanitarian ideal. The industrial engineer is fully as important an item in the history of the workers' emancipation from the barbarity of the "industrial revolution" as the efforts of the workers themselves.

Commenting on the report, Dr. H. E. Howe, of the National Research Council, a leader in industrial and engineering chemistry, says, "It will be news to many people that there are still so many industries in which the long shift is in vogue, and the report contains suggestions which ought to lead to earnest experiments in the near future. For example, it is a novel suggestion that, in changing from two to three shifts in continuous industries, the men be paid the same rate per hour, thereby establishing a basic wage equivalent to two-thirds their income on the longer day; and yet if this wage were supplemented with a bonus graded upon performance, it would be possible for the more proficient to make their income equal to that before the change."

The city council of Buffalo recently rejected the idea of holding a referendum at the next election on the question of whether the city should establish a municipal electric-power plant. The recommendation was voted down because of disagreement regarding the possible cost of such a plant and because the city lacks authority to sell electricity for power purposes to its inhabitants.

Detroit N.A.S.E. Has Good Educational Program

Detroit Association No. 1, N.A.S.E., has prepared an excellent program for its educational work during the coming winter. The following is an outline of the principal subjects to be studied:

1. Chemistry of coal and other boiler fuels.
2. Economical combustion and the necessary apparatus.
3. The effect of different arrangements of baffles in boiler tubes.
4. The design of riveted butt joints.
5. Scientific explanation of the D-slide valve; the riding cutoff valve.
6. Evolution of the Zeuner diagram.
7. The Corliss valve.
8. Selection of motors and starters.

The Association is now in new headquarters, in the Riverside Temple, corner of Baker & Hubbard Streets.

Water-Power Projects

The City of Los Angeles has altered its application to the Federal Power Commission in connection with its Owens Gorge project, so as to ask for a license rather than a preliminary permit. Action on this application is being withheld pending the outcome of litigation between the city and the Southern Sierras Power Co. If the verdict is favorable to the city, it is believed it will begin in the near future the extension of its aqueduct system and the development of the additional

Industrial Revival Is Reported General

Encouraging Reports From All Sections—Unemployment No Longer an Issue—Basic Industries Operating Near Capacity

CONDITIONS encouraging to the industrial advancement of the country are shown in the report of the United States Employment Service for October. In practically every state sound conditions in the basic industries and in the building industry are reported.

An increase in employment is noted in twelve of the fourteen major industrial groups, namely: Railroad repair shops, stone, clay and glass products, iron and steel, chemicals and allied products, vehicles for land transportation, lumber and its manufacture, metal and metal products other than iron and steel, miscellaneous industries, paper and printing, leather and its finished products, textiles and food.

The oil industry shows marked improvement in the Southwest; silk mills are experiencing a lively revival in the Middle Atlantic States, and the iron and steel industry is rapidly recovering everywhere, although a car and labor shortage seems to be holding up operations and employment to 75 per cent production.

Of sixty-five cities reporting, fifty-six showed increases in employment and only eight, decreases. These eight were Toledo, Dayton, Indianapolis, Louisville, Perth Amboy, Fall River, Peoria and San Francisco. Columbus, Ohio, maintained an even balance.

For New York State the bureau has an especially encouraging report, showing that conditions are generally improved to the point where unemployment is no longer an issue.

The monthly report of the Philadelphia Reserve Bank takes an entirely hopeful view of the trade revival. That the movement of business is definitely upward, it reports, "is no longer open to question. The improvement during the last few months has been consistent and rapid, and although much of the betterment during the last six weeks is attributable to seasonal influences, the larger part, by far, represents fundamental business recovery. Manufacturers report that business during October has been in most cases better than that during September."

From Chicago comes the report that business in that section has reached the largest volume since the spring of 1920, with a more healthy feeling all around and a strengthening in the values of many commodities. The striking feature is the increased buying of cars by the railroads—45,000 freight cars for the West and 700 passenger cars, with more inquiries in sight.

power covered by previous applications. The total approximates 150,000 hp.

During the year ended Oct. 31, ninety-six applications for licenses and preliminary permits were received by the Federal Power Commission. This is a material decrease in the rate at which these applications are being received. During the first sixteen months of its existance, 260 applications were received. It is estimated that applications in the future will be received at a fairly constant rate of some seventy-five annually.

New Publications

A Study of Air-Steam Mixtures. By Leroy A. Wilson, with Charles Russ Richards. Bulletin No. 131, Engineering Experiment Station, University of Illinois, Urbana. Paper; 6x9 in.; 96 pages; 9 charts. Price 75c.

This bulletin is a sequal to No. 130, "The Reheating of Compressed Air," reviewed in *Power* for Oct. 31, page 707. In the original investigation, the employment of steam as a reheating agent for compressed air used in an engine operating expansively was found to result in an increased thermal efficiency for the mixture of air and steam, as compared with the use of air or steam separately. These results were such as to justify a further study of air-steam mixtures.

A comprehensive, illustrated digest of this bulletin will be given in the next issue of *Power*.

War Surplus. Published by the Sales Promotion Section, Office of Director of Sales, War Department, Washington, D. C. Free.

This small booklet describes in a general way the War Department's sales methods in disposing of its vast stocks of surplus property. It tells what these stocks contain and an insert lists the more important sales in the near future.

Personals

The resignation of **Dr. George Otis Smith** as director of the United States Geological Survey, so that he could qualify legally as a member of the President's coal commission, has placed the full responsibility for the conduct of the Survey during the next eleven months in the hands of **Philip S. Smith**, who has been serving as the Survey's administrative geologist. The new director has spent practically his entire career on the staff of the Survey and is thoroughly conversant with its work. He is widely known as an unusually capable geologist, with which he combines great executive capacity.

Simultaneously with Dr. Smith's resignation came the announcement that **David White** has retired as the Survey's chief geologist to resume his research work. He has been succeeded by **W. C. Mendenhall**, a member of the Survey staff for the last twenty-eight years. Mr. Mendenhall's geological field work has extended from the southern Appalachians to Alaska. For more than ten years he has served as geologist in charge of the Land Classification Board. This latter place will be filled by the promotion of **Herman Stabler**.

Society Affairs

Metropolitan Section, A.S.M.E., has made excellent arrangements for the dinners preceding its regular meetings in New York City. These dinners will be held at the Building Trades Club, 34 West 33d St., at $1.50 a plate. Those desiring to attend should communicate with G. I. Rhodes, 115 Broadway, Rector 9670, not later than one day before the date of meeting. The first dinner, held before the Nov. 14 meeting, was greatly enjoyed by a large number of members, and the committee urges everyone to take advantage of this opportunity of getting acquainted.

Coming Conventions

American Society of Mechanical Engineers, 29 West 39th St., New York City. Annual meeting at New York City, Dec. 4-7.

American Society of Refrigerating Engineers; W. H. Ross, secretary, 154 Nassau St., New York City. Annual meeting at New New York City, Dec. 4-6.

National Exposition of Power and Mechanical Engineering. Grand Central Palace, New York City, Dec. 7-13.

Kansas Engineering Society; T. M. Averill, secretary, Topeka, Kan. Annual meeting at Topeka, Dec. 14-15.

American Association for the Advancement of Science; L. O. Howard, secretary, Smithsonian Institution, Washington, D. C. Annual meeting at Boston, Dec. 26-30.

American Engineering Council; L. W. Wallace, secretary, 24 Jackson Place, Washington, D. C. Annual meeting at Washington, D. C., Jan. 11-12.

Iowa Engineering Society; Lloyd A. Canfield, secretary, 406 Flynn Bldg., Des Moines. Annual meeting at Des Moines, Jan. 23-26.

American Society of Heating and Ventilating Engineers, 29 West 39th St., New York City. Annual meeting: Jan. 23 at New York City, Jan. 24-26 at Washington, D. C.

American Institute of Electrical Engineers, 29 West 39th St., New York City. Mid-winter convention at New York City, Feb. 14-16.

American Institute of Mining and Metallurgical Engineers, 29 West 39th St., New York City. Annual meeting at New York City, Feb. 19-21.

Affiliated Technical Societies of Boston will meet Nov. 23, at Lorimer Hall, Tremont Temple, to consider "Aviation—Present State of the Art with Special Reference to the Development of Boston as an Air Port." Prof. E. P. Warner of M.I.T. and Edward Schildauer of the American Investigation Corp., Washington, D. C.

Bridgeport (Conn.) Branch, A.S.M.E., will meet Nov. 23 at the Stratfield Hotel, jointly with the Engineers' Club, Chamber of Commerce, Manufacturers' Association, Chemical Society, Rotary and Kiwanir Clubs. E. W. Carpenter, president of E. F. Houghton Co., will speak on "Individualism vs. Socialism."

Virginia Sections, A.S.M.E., A.I.E.E. and **A.S.C.E.** will hold a joint meeting Nov. 24-25 at Virginia Military Institute, Lexington.

Atlanta Section A.S.M.E., will meet Nov. 28 at Town Hall, Chamber of Commerce, for an address on "Diesel and Semi-Diesel Engines vs. Small Steam Engines in Power Stations up to 500 kw. Capacity," by R. H. Cunningham, Southern representative, Ingersoll-Rand Co., Birmingham. There will be discussion by E. B. Hall, of Ames Iron Works, and W. H. Davidson, of Fulton Iron Works.

Waterbury (Conn.) Branch, A.S.M.E., and **Connecticut Section, A.I.E.E.,** will hold a joint meeting on Nov. 23 at Chamber of Commerce Hall. "Waterbury's Power Supply" will be the subject of a talk by Irvin W. Day, vice-president of Connecticut Light & Power Co. Alexander J. Campbell will speak on "Power Distribution"; Paul Spencer, on "Electrical Problems Involved," and Rollin Norris, on "Relation of Water Powers to the Situation."

Business Items

The Risher Firebrick Co., an Illinois corporation capitalized at $40,000, has established offices and warehouse facilities at 18th and Canal Sts., Chicago. The company will carry an unusually complete stock of high-grade refractories, particular attention being given to stocking special shapes. **H. E. Risher**, president and treasurer, is well known in firebrick circles.

Fuel Prices

BITUMINOUS COAL

The following table shows the trend of the spot steam market in various coals (mine run bases, f.o.b. mines):

Coal	Market Quoting	Nov. 6, 1922	Nov. 13, 1922
Pool 1,	New York	$4.75-5.00	$4.75-5.00
Smokeless,	Columbus	5.50-6.50	6.00-6.50
Clearfield,	Boston	3.00-4.00	3.00-3.75
Somerset,	Boston	3.25 4.00	3.25-4.25
Kanawha,	Columbus	4.25 4.75	4.00-4.50
Hocking,	Columbus	3.50-3.75	3.25-3.75
Pittsburgh No. 8	Cleveland	3.56	3.56
Franklin, Ill.,	Chicago	4.00 4.25	4.00-4.25
Central, Ill.,	Chicago	3.00-3.25	3.00-3.25
Ind. 4th Vein,	Chicago	3.75 4.00	3.75-4.00
West Ky.,	Louisville	2.25-2.75	2.35-2.75
Big Seam,	Birmingham	2.25-2.50	2.25-2.50
S. E. Ky.,	Louisville	4.00-4.50	4.00-4.50

FUEL OIL

New York—Nov. 16, Port Arthur light oil, 22@25 deg. Baumé, 4¼c. per gal.; 30@35 deg., 5¼c. per gal., f.o.b. Bayonne, N. J.

Chicago—Nov. 11, for 24@26 deg. Baumé, 90c. per bbl.; 32@36 deg., 2¾@3c. per gal. in tank car, f.o.b. Oklahoma refinery, or freight adjusted.

Philadelphia—Nov. 13, 26@28 deg. Baumé, Oklahoma, 97½c.@$1.05 per bbl.; 30@34 deg., Oklahoma (group 3), 2¾@3c. per gal.; 16@20 deg. Seaboard, $1.35@$1.40 per bbl.

St. Louis—Nov. 7, f.o.b. Oklahoma 24@26 deg. $1.00 per bbl.; 26@28 deg. $1.05 per bbl.; 28@30 deg., $1.10 per bbl.; Gas oil 32@36 deg. 2¾c. per gal.; 36@40 deg. distillate, 3@3¾c. per gal.

New Plant Construction

PROPOSED WORK

Ark., Smackover—The Arkansas Power & Light Co. is having plans prepared for the construction of a power plant, including the installation of two 150 hp. gas engines, two 155 hp. generators. Estimated cost $25,000. W. D. Terry, Engr.

Calif., Alameda—The Alameda Sanitarium, K. Creedon, Dir., 2054 Clinton Ave., plans the construction of a 3 story hospital on Clinton Ave. and Willow St. Estimated cost $250,000. Architect not selected.

Calif., Bakersfield—The Bd. Supervisors of Kern County will receive bids until Dec. 18, (change of date) for the construction of a group of buildings for the county hospital on Flower St., here. Estimated cost $500,000. C. H. Biggar, Bank of Italy Bldg., Archt. Equipment detail not reported. Noted Nov. 14.

Calif., Fresno — The Fresno Consumers Ice Co., Mono and P Sts., plans to build a 3 story, 90 x 96 ft. addition to ice plant.

Calif., Livermore—The U. S. Veterans' Bureau, C. R. Forbes, Dir., Arlington Bldg., Wash., D. C., will receive bids until Dec. 18 for plumbing, heating and ventilating work, refrigerating machinery and electrical work in connection with 29 buildings at the U. S. Veterans' Hospital, here.

Calif., Pescadero—The Ano Nuevo Water District, C. F. Humphrey, Representative, 1212 Merchants Natl. Bank Bldg., San Francisco, plans the construction of 2 dams, one 53 ft. high, 387 ft. long on top, 32 ft. long on bottom, 20 ft. wide, earth fill; the other, 30 ft. high, 200 ft. long on top, 30 ft. long on bottom, 15 ft. wide, earth fill; 3,700 ft. earth ditch, 500 ft., 8 in. pipe line; 6 in. centrifugal pumping plant with 30 hp. gas engine.

Calif., San Francisco — The Bd. Pub. Works will receive bids until Dec. 6 for furnishing and delivering F.O.B. Hetch Hetchy Junction, Tuolumne County, about 26 mi. from Oakdale, one 4 motor traveling crane for use in Moccasin Creek power plant, to be 8 wheel type with max. working load of main hoist 270,000 lbs. and auxiliary hoist, 30,000 lbs. Approximate maximum speeds of operation with full working loads shall be as follows: main hoist 4 to 5 ft. per min., auxiliary hoist 25 to 28 ft. per min. and trolley and bridge travel 60 to 80 ft. per min. M. M. O'Shaughnessy, City Hall, Engr.

Calif., San Francisco — The city and county of San Francisco are having plans prepared for the construction of pipe section of Hetch Hetchy aqueduct between Irvington and Crystal Springs, 19 mi. long and 60 in. dia., riveted steel or welded and 2,050 ft. submerged pipe at Dumbarton Crossing, also pumping plant to pump water to Crystal Springs reservoir. Estimated cost $5,000,000. M. M. O'Shaughnessy, City Hall, Ch. Engr. N. A. Eckart, Ch. Engr. for Hetch Hetchy Project.

Calif., San Francisco — The Western States Life Ins. Co., 6th and Market Sts. is having plans prepared for a 15 story annex to its office building. Estimated cost $800,000. Reid Bros., 105 Montgomery St., Archts. Equipment detail not reported.

Calif., Watsonville — The College Lake Drainage Dist. 2, had plans prepared for 1,124 cu.yds. dry excavation, also installation of motors, one 10 in. and one 5 in. Pacific Krogh centrifugal pumps or equal, 5,000 cu.yds. lake bed excavation, etc. Estimated cost $14,000. H. B. Kitchen, Consult. Engr.

Conn., Hartford—The Phoenix National Bank, 288 Main St., is having plans prepared for a 60 x 170 ft. bank and office building on City Hall Sq. Estimated cost $500,000. Dennison & Hirons, 357 Lexington Ave., Archts. Equipment detail not reported. Noted Nov. 7.

Fla., Daytona Beach — The Peninsular Ice & Cold Storage Co., G. G. Bailey, Pres., will receive bids about Dec. 1st for 15 ton ice manufacturing and cold storage plant, including electric power plant, 400 hp. Estimated cost $30,000.

Fla., McIntosh—The McIntosh Utilities Inc., N. A. Russell, Treas., plans the construction of a cold storage and ice manufacturing plant. Estimated cost $50,000. Architect not announced. Owner is in the market for machinery and equipment.

Ga., Atlanta—J. M. E. Bowman, Biltmore Hotel, 44th St. and Vanderbilt Ave., New York City, has had plans prepared for the construction of a hotel, here. Estimated cost $7,000,000. Schultze & Weaver, 17 East 49th St., New York City, Archts. and Engrs. Equipment detail not reported.

Idaho, Lewiston—The city, E. G. Wagner, Supt. Waterworks, plans the construction of a filtration plant to purify water from the Clear Water River, 6,000,000 gal. per day capacity, also new reservoir, pumps and enlargement of water mains. Estimated cost $350,000. L. Remark, Engr.

Ill., Chicago—The Aetna Sand & Gravel Co., 11 South La Salle St., is in the market for one 18 x 72 in. boiler for steam and one 12 x 54 in. locomotive boiler.

Ill., Chicago—The Continental Casualty Co., 910 South Michigan Ave., plans the construction of a 12 story, 100 x 180 ft. office building, including steam heating system, on 22nd St. and South Park Ave., Estimated cost $1,600,000. Architect's name withheld.

Ill., Chicago — The Covenant Club, c/o W. W. Ahlschlager, Archt., 65 East Huron St., is having plans prepared for a 10 story, 80 x 92 ft. club and office building, including steam heating system, on Dearborn St. Estimated cost $1,000,000.

Ill., Chicago—H. Sierks, Archt., 5036 Lincoln Ave., is receiving bids for a 5 story, 250 x 340 ft. store and apartment building, including steam heating system, on Lincoln and Winnemac Sts., for E. Planer, 2016 West 35th St. Estimated cost $600,000.

Ill., Chicago—J. R. Thompson, 350 North Clark St., plans the construction of a 22 story, 70 x 160 ft. hotel and clubhouse, including steam heating system, on Madison and Dearborn Sts. Estimated cost $3,000,000. Architect's name withheld.

Ill., Chicago—The Union League Club, Jackson and Federal Sts., plans the construction of a new 20 story, 100 x 150 ft. club house. Estimated cost $3,000,000. Mundie & Jensen, 39 South LaSalle St., Archts. Equipment detail not reported.

Ia., Cedar Rapids—Linn County voted $750,000 bonds for the construction of a court house here.

Ia., Knoxville—The U. S. Veterans' Bureau, Quartermaster General's Office, 2306 Munitions Bldg., Wash., D. C., will receive bids until Dec. 12, for the construction of a neuro-psychiatric hospital, here, consisting of 15 buildings, including water, lighting, heating and sewer systems, roads and walks. Noted Nov. 14.

Ky., Louisville—The Gibbs-Inman Co., 825 West Bway, is in the market for machinery and equipment, including motors, transmission equipment, etc., for $110,000 printing plant.

La., Houma—The Mayor and Bd. of Aldermen will receive bids until Dec. 19 for the construction of waterworks system as follows: pumping plant 1,000,000 gal. daily capacity, 3 units 1,000 g.p.m. motor driven, oil engine generator sets, mechanical filtration plant 1,000,000 gal. daily capacity, storage reservoir, 10,000,000 capacity, about 800 ton c.i. mains and 1 mi. transmission lines, electric power station and filter structures. G. W. Fuller, 170 Bway., New York, Consult. Engr.

Md., Baltimore—D. C. Elphinstone, 408 Continental Bldg., is in the market for an electrically operated crane 75 ft. beam, capable of handling a 2 yd. clamshell on 60 ft. radius, also an electrically operated shovel 3 yd. dipper, caterpillar or traction tread., etc.

Mass., Warren—The city plans the construction of water supply system, including piping, reservoir, pumping plant, etc. Engineer not selected.

Mich., Detroit—L. Smilansky, 1332 Book Bldg., plans the construction of a 14 story, 166 x 342 ft. theatre and hotel building on Woodward and High Sts. Estimated cost $12,000,000. Architect not announced.

Minn., Duluth—The Duluth Presidential Hotel Co., c/o Whiting Wall Co., Torrey Bldg., is having plans prepared for the construction of a 10 story, 140 x 160 ft. hotel, including steam heating with mechanical ventilating system, on Superior St. and 9th Ave. E. Estimated cost $1,000,000. Holstead & Sullivan, 407 Palladio Bldg., Archts. and Engrs.

Minn., Glen Lake (Hopkins P. O.)—The Hennepin County Sanatarium Comrs., E. S. Mariatte, Secy., Hopkins, R.D., received bids for the construction of a 45 x 108 and 12 x 32 ft. power house at the County Sanatarium here, from Pehrson Bros., 555 Temple Court, Minneapolis, $229,500; J. Peterson, 3152 10th Ave. S., Minneapolis, $239,500; Pike & Cook, 416 South 5th St., Minneapolis, $244,627. Rose & Harris, 318 Auditorium Bldg., Engrs.

Mo., Fredericktown—The city council is in the market for 2 complete oil burning power units for municipal lighting plant. Estimated cost $25,000.

Mo., Joplin—The Commercial Chat Co., 206 Independent Bldg., 206 West 3rd St., A. G. Gaubert, Purch. Agt., is in the market for a 60 to 70 horse power gas engine.

Mo., St. Charles—The City plans election Dec. 2, to vote $65,000 bonds for waterworks improvements, including two 350 g.p.m. motor driven pumps. A. L. Mullergren, 555 Gates Bldg., Kansas City, Engr.

Mo., St. Louis—The Bd. Educ., 9th and Locust Sts., received bids for heating and ventilating apparatus including air washer and heat regulation No. 2285 for proposed Edward Long grade school, on Morganford Rd. and Walsh St., from E. P. Ambler, 2822 La Salle St., $35,052, Urbauer-Atwood Heating Co., 1452 South 2nd St., $35,090, Sodemann Heating & Power Co., 23rd and Morgan Sts., $37,237; No. 2291, proposed 1 story, 40 x 50 ft. addition to Sumner High on 2nd Ave., from Bradley Heating Co., 3834 Olive St., $11,900, E. P. Ambler $17,795; No. 2279, two story, 95 x 221 Cyrus P. Waldbridge grade school on Davison and Lillian Aves., E. P. Ambler, $35,052, Urbauer-Atwood Heating Co., $35,090, Sodermann Heating & Power Co., $35,237. Noted Oct. 24.

Mo., St. Louis—D. Israel, Washington Hotel, plans to build a 12 story, 140 x 165 ft. hotel on 20th and Chestnut Sts. Estimated cost $800,000. Equipment detail not reported.

Mo., St. Louis—The Light Development Company of St. Louis, Railway Exchange Bldg., is having plans prepared for the construction of a 20,000 kw. power plant on the Mississippi River, here, to supply light and power to the city. Estimated cost $2,000,000. Engineering Dept. in charge.

Mo., St. Louis—The Travelers Protective Assn. of America, J. H. Stafford, Secy. and Treas., Syndicate Tr. Bldg., plans to build an office building. Estimated cost $1,000,000. Architect and Engineer not selected.

Mo., St. Louis—The U. S. Public Service Co., Railway Exchange Bldg., are having plans prepared for extending transmission lines 15 mi. in southeast Missouri, 40 mi. in Texas, and several miles near Mitchell, S. D., $125,000; enlargement of various power plants, $200,000, extensions and equipment for same, $200,000. The above amount is part of $1,100,000 bond issue recently disposed of by U. S. Pub. Serv. Co. Balance of proceeds were used to reimburse the Light & Development Co., Ry. Exch. Bldg., for moneys expended in extending lines, etc., controlled by company. These companies are inter-related, the U. S. Public Serv. Co., being a sort of financing company for the other, although it does not control all of plants owned by the Light & Development Co.

Mo., St. Louis—The Dept. of Water, G. Oetting Supply Somr., City Hall, is in the market for two 1,000 hp. feed water heaters.

N. J., Newark—The Elks B. P. O. No. 21, 37 Green St., plans the construction of a 12 story, 100 x 150 ft. Elks Home on Broad and Camp Sts. Estimated cost $1,000,000. McKim, Mead & White, 101 Park Ave., New York, Archts. N. J. Convery, 942 Broad St., Assoc. Archt. Equipment detail not reported.

N. Y., Buffalo—The Bd. Educ. received bids for the construction of school No. 7 on Newburgh Ave., as follows: general contract, Tifft Constr. Co., Iroquois Bldg., $322,800; Eastern Concrete Steel Co., Morgan Bldg., $329,400, C. H. Everitt, 295 Auburn Ave., $336,000; heating and ventilating, R. J. Moran, 379 East Utica St., $64,000, J. J. Bresnahan, 462 Elk St., $64,974, J. W. Danforth Co., 70 Ellicott St., $67,986. Noted Nov. 7.

N. Y., Niagara Falls—P. A. Schoellkopf, Chn. Executive Com., c/o Chamber of Commerce, plans to build a hotel. Estimated cost $1,000,000. Architect not announced.

N. C., Asheville—The Georgia Talc Co. is in the market for several electric motors, various sizes, transformers and other electrical equipment.

N. C., Elizabeth City—The city, W. B. Goodwin, Mayor, authorized $550,000 bonds for the construction of waterworks, electric light and power plant. W. C. Olsen, Kinston, Eng.

N. C., Elizabeth City—The Crystal Ice Co., plans the construction of a 1 story addition to ice manufacturing plant and extensive improvements, to present plant. Estimated cost $100,000. Ophuls & Hill, 112 West 42nd St., New York, Engrs.

N. C., Greensboro—The Southern Power Co., 432 South Church St., Charlotte, plans the construction of a switching station, near 4 mi. post on Southern Ry., near here, extension of transmission lines from Lookout Shoals, near Statesville, to Winston-Salem and from here to High Point, also considering moving present steam plant on Battleground Rd. to a point near new distributing station. Estimated cost $1,000,000. W. S. Lee, 433 East Morehead St., Charlotte St., Engr.

N. C., Halifax—The N. L. Stedman Co., A. Stedman, Purch. Agt., is in the market for one crude oil engine, large enough to pull a 4.70 saw cotton gin.

N. C., Kings Mountain—The Bd. Comrs. will receive bids until Nov. 27, for improvements to waterworks and sewerage system, including a 500,000 gal. reservoir, small pumping station, sewage sedimentation tank, also the furnishing and laying 2 mi. 6 to 14 in. water mains and accessories, building 2 mi. sewers and furnishing 8 and 10 in. sewer pipe, etc.

Ohio, Cleveland—The city passed an ordinance to expend $175,000 for improvements as follows: cables and accessories, $40,000; ducts, manholes and underground equipment, $15,000; transformers, poles and wire equipment, $55,000; labor and engineering, $65,000. G. Beckwith, City Hall, Engr.

Ohio, Cleveland—Koller Bros., Co., G. Koller, Pres., 724 Prospect Ave., is receiving bids for the construction of a 9 story, 50 x 85 ft. hotel, including steam heating system, at 633 Huron Rd. Estimated cost $250,000. J. L. Cameron, 10406 Euclid Ave., Archt.

Ohio, Columbus—The Doddington Co., 451 West Broad St., T. A. Jones, Gen. Mgr., is in the market for 20 motors, 3 to 25 hp. for new plant on Duerr Rd.

Ohio—Toledo—The Chevrolet Motor Co., General Motors Bldg., Detroit, Mich., is having plans prepared for the construction of a 1 story, 91 x 450 ft. plant for the manufacture of automobile transmission, a 1 story 100 x 120 ft. heat treating building including equipment and a 60 x 90 ft. power house including light and power equipment. A. Kahn, 1000 Marquette Bldg., Detroit, Mich., Archt.

Okla., Canton—The city H. Wagoner, Clk., plans complete new waterworks and electric light systems. Estimated cost $45,000. V. V. Long & Co., 1300 Colcord Bldg., Oklahoma City, Consult. Engr.

Okla., Okmulgee—The Creek Hotel Co. is having plans prepared for the construction of an 8 story, 100 x 140 ft. hotel on 3rd and Morton Sts. Estimated cost $1,000,000. Smith & Senter, 401 Commerce Insurance Bldg., Archts. Equipment detail not reported.

Okla., Wetumka—The city, C. N. Hamilton, Clk., plans extensions to its water, light and sewer systems. Estimated cost $150,000. V. V. Long & Co., 1300 Colcord Bldg., Oklahoma City, Consult. Engrs.

Ore., Portland—School Dist. 1, G. Thomas, Clk., is having plans prepared for the construction of a 2 story, 72 x 384 ft. Northeast High school administration building, also a 128 x 144 ft. gymnasium and power house. Estimated cost $430,000. Howell & Knighton, U. S. Bank Bldg., Archts.

Pa., New Brighton—The Beaver County Light Co., 435 6th Ave., Pittsburgh, plans the construction of a new power house, here. Estimated cost $35,000. H. Fullerton, 5444 Kincaid St., Pittsburgh, Engr.

Pa., Phila.—P. H. Johnson, Archt., 1713 Sansom St., is receiving bids for a 2 story, 71 x 180 ft. hospital on 34th and Pine Sts., for the Dept. of Health. Estimated cost $250,000. Equipment detail not reported.

Pa., Phila.—The Stanley Company of America, 1218 Market St. is having plans prepared and will soon receive bids for the construction of a 20 story theatre and office building on Broad and Locust Sts. Estimated cost $2,000,000. Hoffman-Henon Co., Finance Bldg., Archts. Equipment detail not reported.

Pa., Pittsburgh—The Bd. Educ. received bids for the proposed 2 story addition to grade school on Rockland Ave. and Beechwood St. as follows: heating and ventilating, from the Steel City Heating & Plumbing Co., 3612 5th Ave., $36,341, Ryan Heating Co., 53 Tunnel St., $36,620, J. A. Langdon 2030 5th Ave., $36,744; motors, Howell Electric Motors Co., 1st Natl. Bk. Bldg., $668., Triumph Electric Co., Ferguson Bldg., $711, Lewis-Allis Co., $824; boilers, Oil City Boiler Wks., 351 Seneca St., Oil City, $4,715, Utica Heater Co., Mohawk and Whitesboro Sts., Utica, $4,975, Ames Iron Wks., 25 East 2nd St., $5,428. P. C. Doroler, Magee Bldg., Archt.

Pa., Pittsburgh—The Schenley Apts. Co., 3929 Forbes St., is having plans prepared for alterations and addition to its 10 story apartment hotel on Forbes and Bigelow Sts. Estimated cost $500,000. Rutan, Russell & Wood, Century Bldg., Archts.

Pa., Scranton—The Scranton Lace Co., Glenn St. and Albright Ave., plans the construction of a new power house in connection with its plant. Estimated cost $60,000.

S. C., Dillon—The town council will receive bids until Dec. 1, for sewer and waterworks, including extension of water and sewer lines, 250,000 gal. reservoir, sewer and installation of pumping machinery. Estimated cost $50,000. Ryan Engineering Co., Arcade Bldg., Columbia, Engrs.

Tenn., Chattanooga—The Dixie Spinning Co., Volunteer Life Bldg., is in the market for complete equipment for new power house, in connection with $500,000 spinning plant.

Ten., Knoxville—The White Oak Corp., South Knoxville, is in the market for one 500 hp. marine type boiler with auxiliary equipment.

Tex., Canton—The city voted $50,000 bonds for waterworks improvements, and electric light plant. O'Neill Engr. Co., Dallas, Engrs.

Tex., Dallas—The Methodist Hospital, Bd. Mgrs., is having plans prepared for the construction of a 4 story hospital on Oak Cliff. Estimated cost $500,000. DeWitt & Lemmon, South Western Life Bldg., and W. B. Ittner, 911 Locust St., St. Louis, Mo., Archts. R. O. Jameson, 342 South Rosemont St., Engr.

Tex., San Antonio—The Methodist Episcopal Church, S. Nashville, is having plans prepared for college buildings including 2 dormitories, fine arts, laboratory and gymnasium, heating plant and president's home here. Estimated cost $250,000. A. B. and R. M. Ayres, 626 Bedell Bldg., San Antonio, Archts.

Va., Strasburg—The Shenandoah Valley Co-operative Milk Producers' Assn, is in the market for complete equipment for proposed power house in connection with milk plant.

Wash., Chelan—The Great Northern Ry. Co., Havermale Island, Spokane, is having plans prepared for an ice manufacturing and cold storage plant, at its yards here. Estimated cost $400,000 to $500,000. W. A. Wells, 601 Hyde Bldg., Archt. and Engr.

Wash., Seattle—The Bd. Pub. Wks., C. B. Bagley, Secy., Rm. 234, County-City Bldg., will receive bids until Dec. 8, for the fabrication and erection of the super-structure, machinery and electrical equipment of a steel bascule bridge and 2 side spans over the West Waterway at West Spokane St.

Wash., Tacoma—The city is having preliminary plans prepared for hydro-electric development to develop 75,000 hp. reservoir to store 190,000 acre ft. of water, power plant, dam, transmission line, etc. Estimated cost $1,768,000.

W. Va., Wheeling—The city, C. H. Dowler, Mgr., will receive bids until Dec. 12 for the design, construction, erection, putting in operation and testing of 2 engine driven centrifugal low service pumping engines, 1 turbine driven centrifugal high service pumping engine, three 350 hp. boilers with stokers and the dismantling, moving and re-erecting of the existing Allis Chalmers pumping engine; also 3 low service and three high service motor driven centrifugal pumping engines in units of 10, 15 and 20 million gal.

Wis., Delavan—The State Bd. of Control, M. J. Tappens, Secy., is receiving bids for motor generator set for the State School for Deaf, A Peabody, Capitol Bldg., Madison, Engr.

Wis., Madison—The J. Heilprin Fruit Co., J. Heilprin, Pres., West Mifflin St., plans the construction of a 2 story, 75 x 150 ft. cold storage warehouse on Bedford St. Estimated cost $90,000. Architect not selected.

Wis., Milwaukee—R. Messmer & Bro., Archts., 221 Grand Ave., are receiving bids for the foundation of a 9 story, 110 x 145 ft. club house on Juneau Pl., for the Milwaukee Elks Lodge, 448 Jefferson St. Estimated cost $1,000,000. Equipment detail not reported. Noted Aug. 15.

Wis., Prairie du Chien—Crawford County, c/o County Auditor, is having plans prepared for the construction of a pumping station, estimated cost $100 000 and 20 mi. of levee work, also the installation of two 36 in. centrifugal pumps operated by 2 electric motors. Estimated total cost $600,000. J. H. Mack, Capitol Bldg., Madison, Engr.

Wis., Racine—The Racine Pure Milk Co., 1010 13th St., is in the market for steam driven refrigeration machinery for dairy.

Ont., Hanover—The city voted $135,000 for extensions to waterworks system, including 3 mi. 6 in. supply pipe to Rheil Lake, also reservoir and tank, and probably new electric centrifugal pumps. F. W. Thorold, 54 Admiral Rd., Toronto, Engr. Noted Oct. 3.

CONTRACTS AWARDED

Calif., San Diego—The Army and Navy Y.M.C.A., 341 West E St., will build an Army and Navy building. Estimated cost $750,000. H. L. Rogers, Archt. Equipment detail not reported.

Calif., Tracy—The Naglee—Burk Irrigation Dist., awarded the contract for furnishing and installing one 12 in. double suction vertical centrifugal pump and one 30 hp. 60 cycle, motor, etc., for pumping plant using Byron-Jackson pump., to the Tracy Electric Co., $2,485. Noted Oct. 24.

Conn., New Britain—The United Hotel Co., 140 Main St., will build by separate contracts, a 5 story hotel on West Main St. Estimated cost $500,000. Equipment detail not reported.

Ill., Chicago—The Chicago Trust Co., 7 West Madison St., awarded the contract for a 14 story, 90 x 99 ft. office building, on Monroe and Clark Sts., to H. Erickson, 139 North Clark St. Estimated cost $1,000,000. Steam heating system will be installed. Noted Sept. 12.

Ill., Chicago—R. S. DeGolyer, Archt., 7 South Dearborn St., awarded the contract for the construction of a 12 story, 107 x 135 ft. hotel on Pearson and Seneca Sts., to Pascher Bros., 111 West Washington St. Estimated cost $2,250,000. Steam heating system will be installed. Owner's name withheld.

Mass., Gardner—The Gardner Hotel Co., c/o H. L. Stevens, Archts. and Engrs., 522 5th Ave., New York, will build by separate contracts, a 5 story, 85 x 100 ft. hotel on Pleasant St. Estimated cost $250,000. Equipment detail not reported. Noted Nov. 7.

Minn., Duluth—St. Louis County awarded the contract for the construction of a 4 story, 49 x 132 ft. county jail on 2nd St. and 6th Ave. W. to Jacobson Bros., Columbia Bldg., $429,700. Steam heating system will be installed. Noted Oct. 10.

Mo., St. Louis—The Famous Players Mo. Corp., c/o N. Frank, Arcade Bldg., awarded the contract for the construction of a 12 story, 120 x 130 ft. office building with special facilities for physicians and surgeons, including hospital on top floor, on Grand Blvd., to the Black Masonry & Contr. Co., Railway Exch. Bldg. Estimated cost $800,000. Equipment detail not reported.

N. Y., Buffalo—The Chevrolet Motor Co., 3044 West Grand Blvd., Detroit, awarded the contract for the construction of a 1 and 2 story, 338 x 900 ft. factory and loading platform, including steam heating equipment, on East Delevan Ave., here, to J. W. Ferguson, 152 Market St., Paterson, N. J. Noted Oct. 31.

N. Y., Rochester—The Eastman Kodak Co., awarded the contract for the construction of an 85 x 119 x 37 ft. power house at Kodak Park, to the Ridge Constr. Co., c/o owner. Estimated cost $85,000.

Pa., Pittsburgh—The Bd. Educ., Fulton Bldg., awarded the contracts for addition to High School on East Carson and South 10th Sts., to the P. H. Kelly Co., 1713 Sansom St., Phila., $452,400; heating and ventilating to R. T. Withers, Newcastle, $73,826. Noted May 16.

Tex., Laredo—The Laredo Hotel Co. awarded the contract for the construction of a 7 story hotel on Hidalgo and San Berdo Sts. to Jambers & Tillman. Estimated cost $260,000. Equipment detail not reported.